SAE Journal

AUGUST 1958

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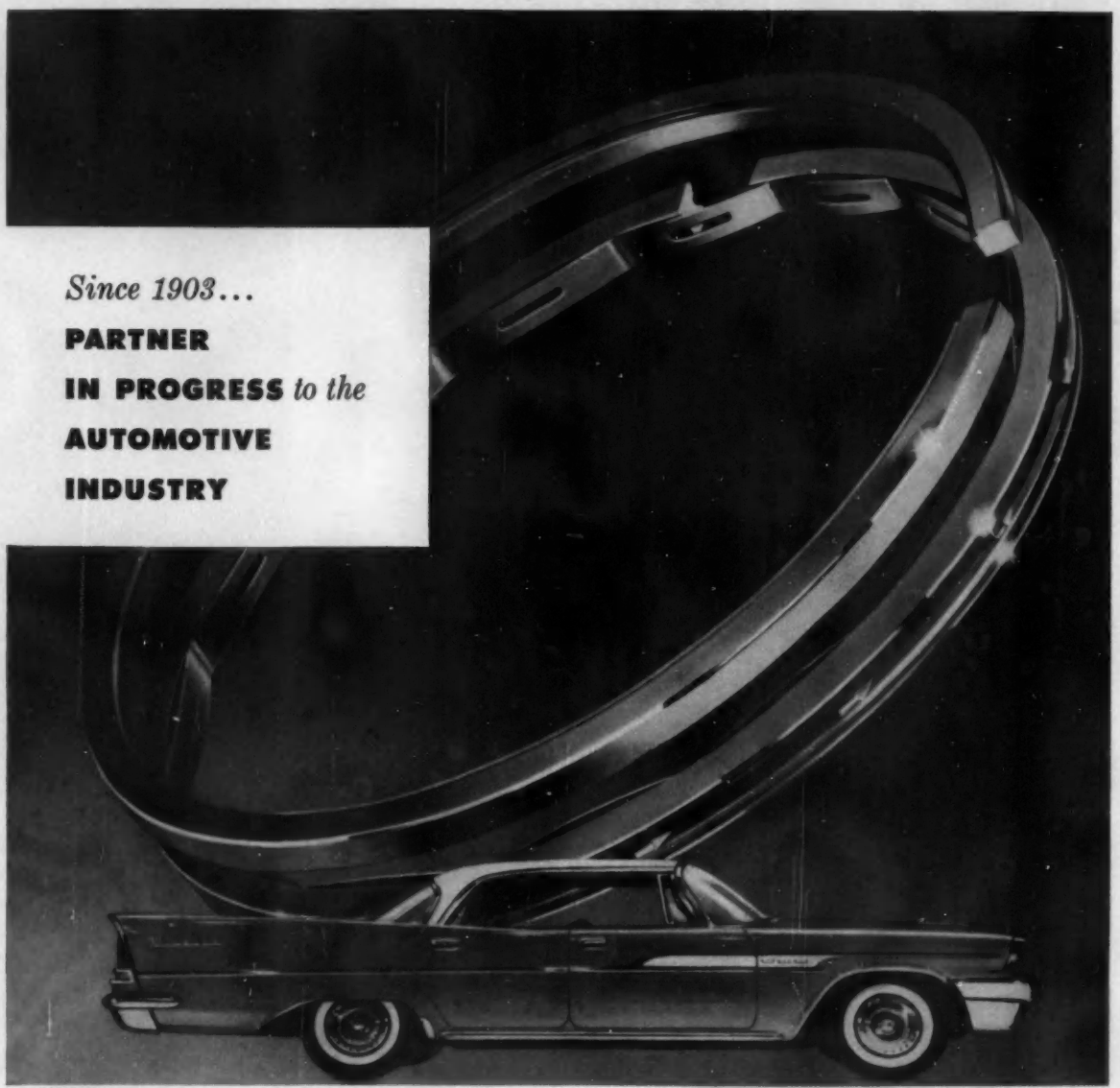

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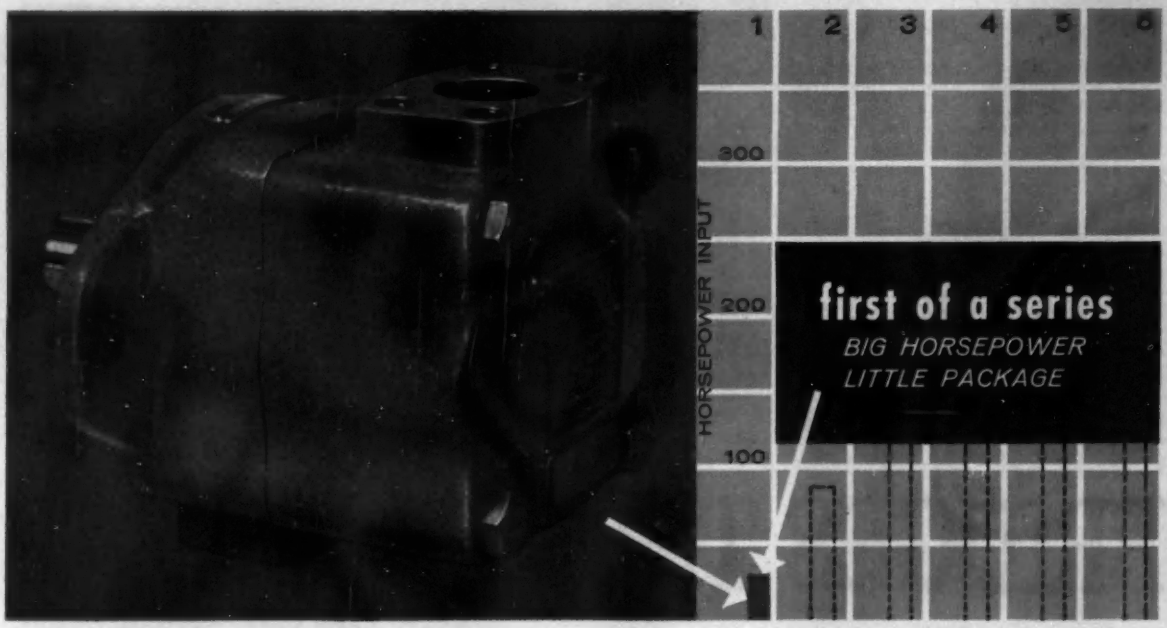

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AIRCRAFT

Selection of Optimum Modes of Control for Aircraft Engines, A. J. SOBEY. Paper No. 49A. Presented Apr. 1958, 19 p. Basic requirements established by their basic objectives, namely: physical limiting, thrust, and transient control; turbojet engine used as basis for discussion of each class of control mode; use of analog computer to evaluate factors affecting optimum performance of engine and weapons system; final selection of control requires compromise between best performance and other design factors.

Nuclear Rocket Propulsion — Survey of Proposed Concepts, T. F. NAGEY. Paper No. 53A. Presented June 1958, 7 p. Massive and coordinated attack on interplanetary travel will be dependent on development of nuclear powered propulsion systems; propulsion schemes advanced for accomplishment of space flight include: "conventional" nuclear rocket, electric propulsion, free radicals, and photon propulsion.

Design and Testing of Solid Propellant Rocket Engines, C. R. VORIS. Paper No. S85. Presented Dec. 1957, (Metropolitan Sec.) 12 p. Paper devoted to type using internal burning, case bonded, composite solid propellants (polysulphide polymers), manufactured by Thiokol Chemical Corp.; method of rating propellants; design criteria for determining materials for inert parts; tabulated test results for group of engines for military services during qualification program.

Low Level Escape in Naval Aircraft, J. H. DRESSEL. Paper No. S86. Presented May 1958, (Metropolitan Sec.) 8 p. Navy's escape program centers around effort to incorporate into system means of lowering minimum altitude at which successful escapes could be made; through abolition of 2-part sequence for ejection, incorporation of automatic lap belt and parachute opener, escape action is reduced to one movement; MK A5 seat designed by Martin-Baker for Royal Air Force and Navy; rocket powered escape systems under development.

Basic Fuel Injection for Business Aircraft, W. A. WISEMAN. Paper No. S90. Presented Apr. 1958, (Western Michigan Sec.) 14 p. Design and operation of system of multi nozzle, continuous flow type which controls fuel flow to match engine air flow, built by Continental Motors Corp.; there are four basic elements in system: injector pump pressurizing fuel, control unit regulating fuel and air, manifold valve which divides fuel, and nozzles which discharge fuel.

Research in Magnetohydrodynamics, W. McILROY. Paper No. 39C. Presented Apr. 1958, 9 p. Several applications, including instruments such as induction flow meter and electromagnetic pump; theoretical investigations at Republic Aviation Corp. concerned with reduction of aerodynamic heating at nose of re-entry missile; possibilities of plasma engine for flight into outer space, and regeneration of electricity from fluid; application of "pinch effect" which will ultimately lead to harnessing of nuclear power for peaceful purposes.

Ion Rocket Engine, R. H. BODEN. Paper No. 41D. Presented Apr. 1958, 39 p. Research work by Rocketdyne Div. of North American Aviation, to seek power plant which would supplement capability of chemical and nuclear rocket engines; design parameters of ion propellant engine developed in terms of three independent parameters; ratio of acceleration voltage to weight of propellant, gross weight of vehicle, and thrust-to-weight ratio;

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three major problems are development of ion thrust chambers, high power generators, and propellants.

Error in Non-Equilibrium Pressure Measurements Following Step and Ramp Pressure Changes, J. F. ALDRICH, S. TRIPOLI. Paper No. S89. Presented Apr. 1958, (San Diego Sec.) 9 p. Working charts worked out by Supersonic Wind Tunnel Group of Douglas Aircraft Co., allow engineer to understand and evaluate lag effects for two common types of pressure histories: step and ramp change; instrument may be manometer or pressure transducer; pressure lag effects are important in operation of intermittent wind tunnels.

FUELS & LUBRICANTS

Single Cylinder Engine Fuel Research, A. W. POPE, Jr. Paper No. SP-218. Presented June 1958, 22 p. Review of work starting in 1928 with Automotive and Petroleum industry joint efforts to measure fuel antiknock quality; six types of laboratory engines produced for motor, aviation and diesel research; instrumentation for indicating gasoline knock and diesel fuel ignition quality; detonation indicator with simplified circuitry for knock rating in range above 100 octane; field of measurement proposed for cooperative research. Horning Memorial Lecture.

Lubricants for Nuclear Reactor Systems, L. W. MANLEY, A. O. PUKKILA, E. G. BARRY. Paper No. 53B. Presented June 1958, 6 p. Three types of exposure used to determine extent of damage to lubricants: high energy electrons from Van de Graaf accelerator, gamma photons from Co 60 and mixed neutrons and gamma particles from reactor; static radiation testing seems useful; dynamic radiation, however, is more realistic for evaluating performance under specific conditions of speed, load, dose rate and temperature.

Simplified Shear Stability Testing, R. RAWSON. Paper No. 57A. Presented June 1958, 7 p. Viscosity index improved oils listed in four groups: automatic transmission and power steering fluids; hydraulic oils; diesel and gasoline engine crankcase oils; multiple grade EP gear oils; Fuel Injector Shear Stability Test (FISST) to determine effect of shear on oils; field and bench test comparisons VI improver products; aircraft hydraulic oils.

Routes of Crankcase Oil Loss, J. S. COON, D. E. LOEFFLER. Paper No. 57B. Presented June 1958, 26 p. Oil consumption tests in laboratory automotive engines equipped with external sumps show that from 1/3–2/3 of oil consumed was lost by way of valve assembly; over 1/3 of reduction in consumption in going from SAE 10 to SAE 30 oil is due to decrease in volatility of blend; results interpreted in terms of oil-loss mechanisms governed by viscosity and volatility.

Multigrade Oils Pay Off in Heavy-Duty Service, C. C. COLYER, J. M. MILLER. Paper No. 57C. Presented June 1958, 11 p. Results of 3,000,000-mi field tests, undertaken to compare multigrade oils with customary single-grade oils in six types of equipment; gasoline and diesel trucks, diesel buses, earthmovers, farm tractors, and taxicabs; qualities studied include fuel and oil mileage, low temperature starting, and engine wear; savings obtained in fuel economy outweigh additional cost.

Laboratory Oil Tests Predict Field Performance of Lubricating Oils, J. A. MILLER, L. M. HARTMANN, J. A. TANTET. Paper No. 57D. Presented June 1958, 26 p. Data from over 6,000,000 mi of field testing and over 800 FL-2 tests are analyzed and correlations presented; use and interpretation of FL-2 and "lead paint" tests provide adequate tools for evaluating gasoline engine lubricating oil per-

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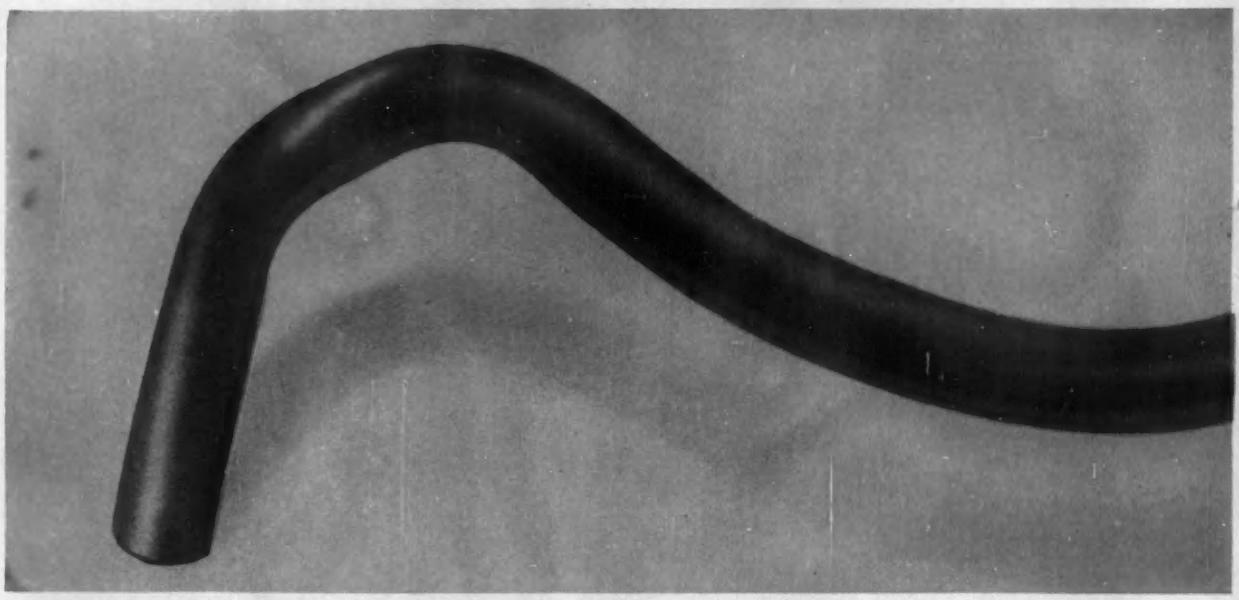

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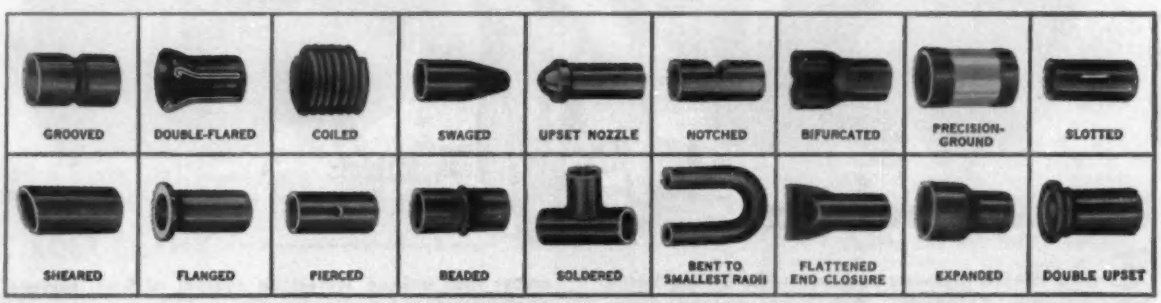

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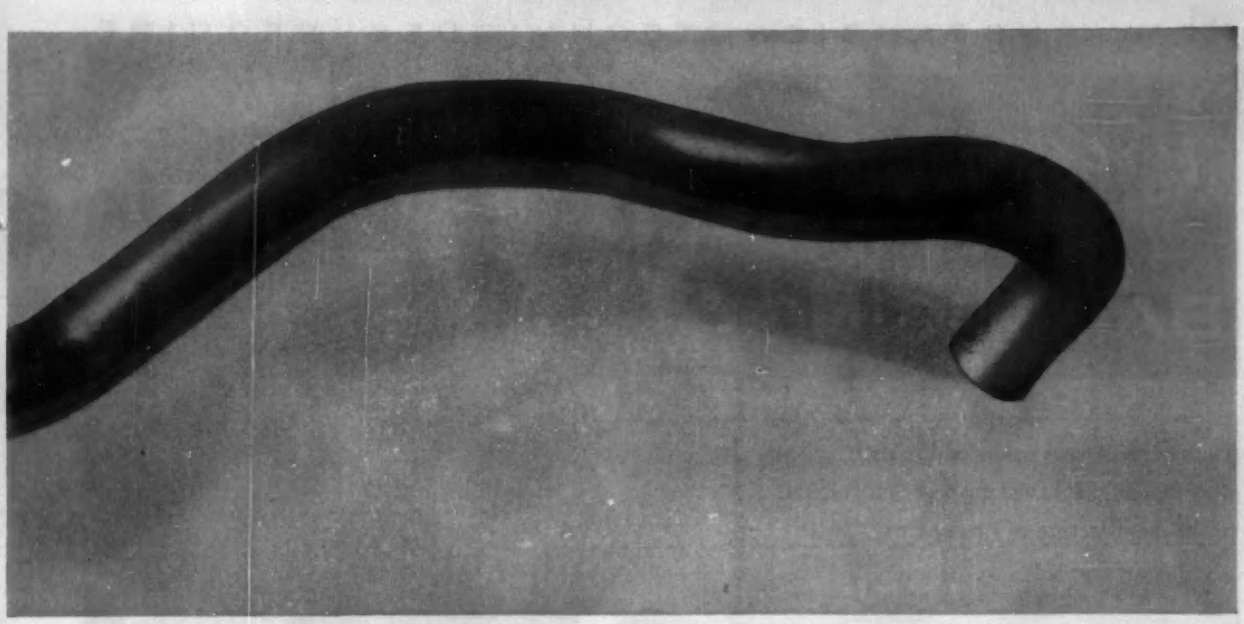

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Bundy Tubing Distributors and Representatives: ***Northeast:*** Chas. H. Stamm, 10 N. Main St., West Hartford, Conn.; Austin-Hastings Co., Inc., 226 Binney Street, Cambridge 42, Mass. • ***Middle Atlantic:*** Atlantic Tube & Metals, Inc., 451 New Jersey State Highway #23, Wayne, N. J.; Rutan & Co., 1 Bala Ave., Bala-Cynwyd, Pa. • ***Midwest:*** Lapham-Hickey Steel Corp., 3333 W. 47th Place, Chicago 32, Ill.; Midco Supply Company, 1346 South 20th Street, Omaha, Neb.; Williams and Company, Inc., 901 Pennsylvania Ave., Pittsburgh 33, Pa. • ***South:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg., Chattanooga 2, Tenn. • ***Mountain:*** M. L. Foss, Inc., 1901-1927 Arapahoe Street, Denver 1, Colo. • ***Southwest:*** Vinson Steel & Aluminum Co., 4606 Singleton Blvd., Dallas, Texas • ***Northwest:*** Eagle Metals Co., 4755 First Avenue, South Seattle 4, Wash. • ***Far West:*** Pacific Metals Co., Ltd., 2187 S. Garfield, Los Angeles 22, Calif.; Pacific Metals Co., Ltd., 1900 Third Street, San Francisco 7, Calif.

Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

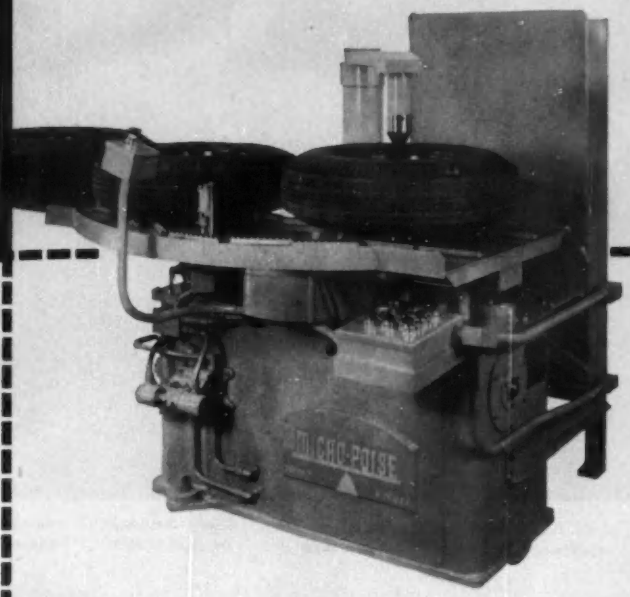
NEW SUSPENSION TECHNIQUES REQUIRE

Production WHEEL BALANCING

The merits of well balanced tire and wheel assemblies have long been recognized in the manufacture of luxury cars.

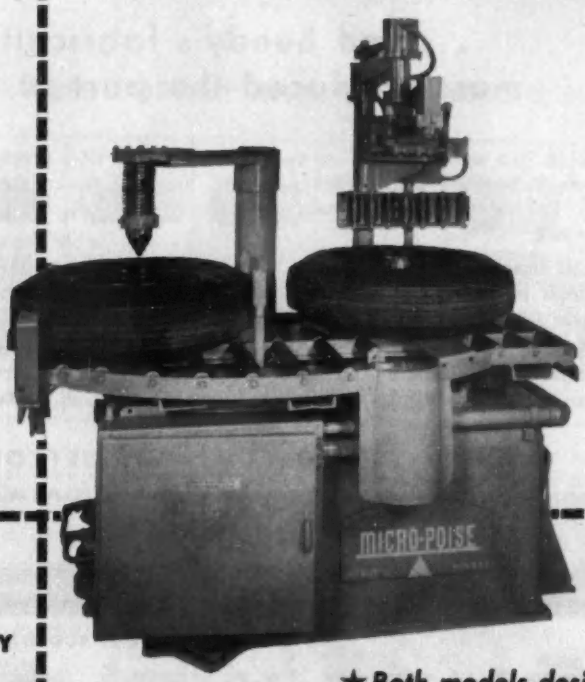
Now new and better suspension methods have pointed up the need for good wheel balance in *all* cars.

Two new Micro-Poise balancing machines, developed especially for the high production needs of the automobile industry, are helping manufacturers economically to extend what was once a luxury car feature to high volume models.



★ *(Above)* **Semi-automatic machine takes pieces from a power conveyor, balances them and locks them in position while an operator reads unbalance information on a universal level. After he applies the correcting weight the finished piece is returned to the conveyor as the next piece comes into position.**

★ *(Right)* **Fully automatic machine takes pieces from power conveyor and delivers them back to conveyor balanced and marked for correction in terms of weight and location.**



★ ***Both models designed for installation in existing automatic mounting and inflating lines.***

MICRO-POISE
ENGINEERING AND SALES COMPANY

14851 Grand River Avenue
Detroit 27, Michigan

Phone: VErmont 8-1134

NATIONAL OIL SEAL LOGBOOK

Ask yourself these questions when specifying oil seals

SHAFT RPM, FPM, RUNOUT, ENDPLAY	Is seal rated at or above my anticipated operating extremes? ☐ YES ☐ NO
TEMPERATURE, LUBRICANT TYPES	Will heat or special-purpose lubricants attack my sealing lip compounds? ☐ YES ☐ NO
PRESENCE OF DIRT OR OTHER FOREIGN MATERIAL	Point often overlooked. If present, should I specify dual-lip sealing member? ☐ YES ☐ NO
COST RELATED TO SEAL DESIGN	Will a simpler, less expensive seal do as good a job as a more sophisticated unit? ☐ YES ☐ NO
NEW SEAL DESIGNS AND MATERIALS ON MARKET	Are there new high temperature, high speed compounds I should examine before specifying? ☐ YES ☐ NO
SPECIAL DESIGNS FOR SPECIAL PROBLEMS	Not all sealing jobs can be met with stock seals. Do I need a special factory design? ☐ YES ☐ NO
DELIVERY, REPUTATION FOR QUALITY	Is my resource noted for on-time delivery, uniform quality, and good follow-up service? ☐ YES ☐ NO

Don't specify "blind." Your National Oil Seal Engineer has up-to-date data on seals—old, new and under development. He understands current sealing parameters; what special designs can probably be developed. His frank, free counsel can't help but lead to better sealing, faster assembly, simpler servicing, faster delivery or lower cost.

Call him today. Number's in the Yellow Pages, under Oil Seals.

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Plants: Redwood City and Downey, California
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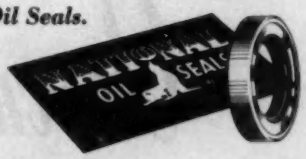

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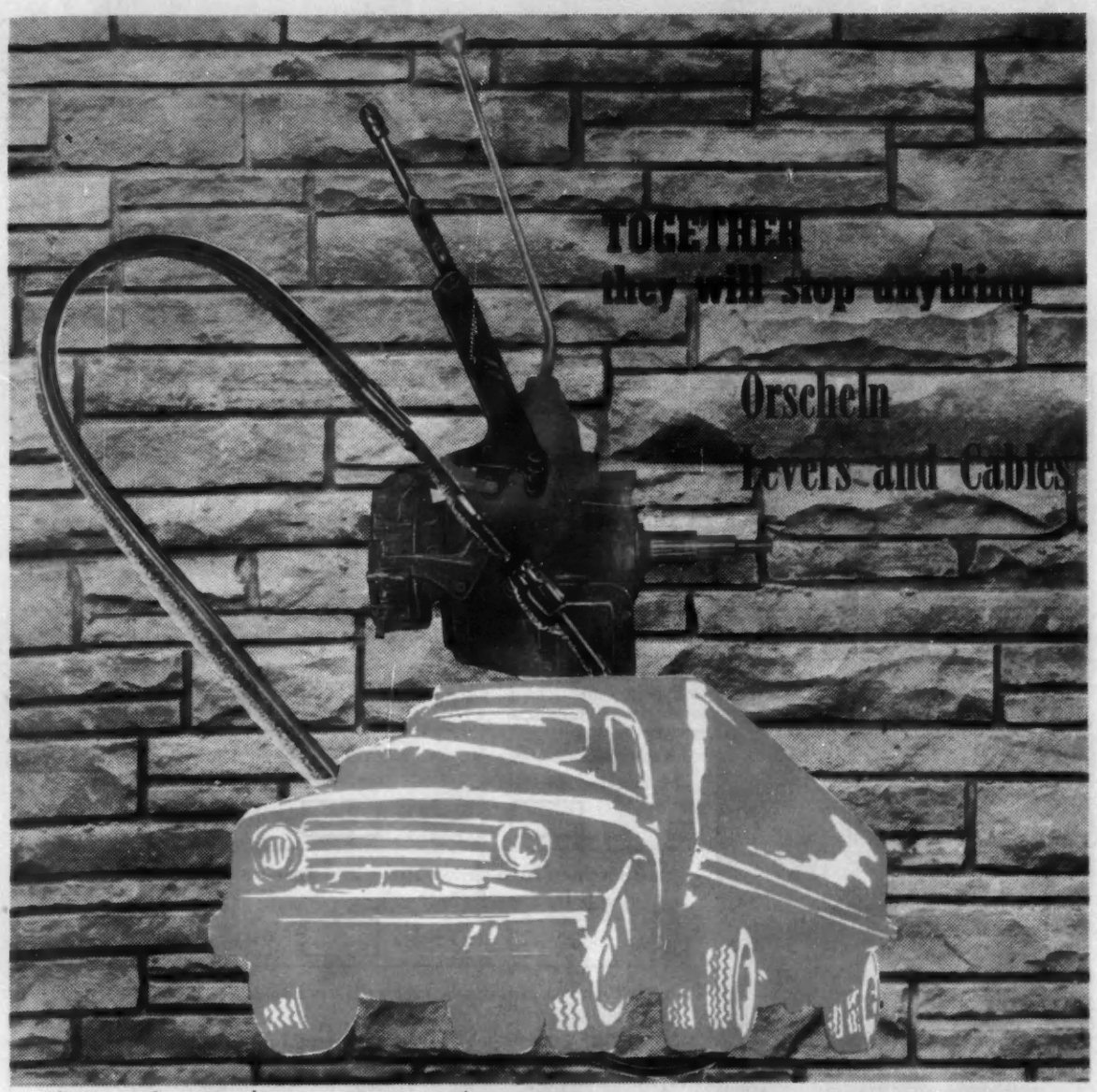


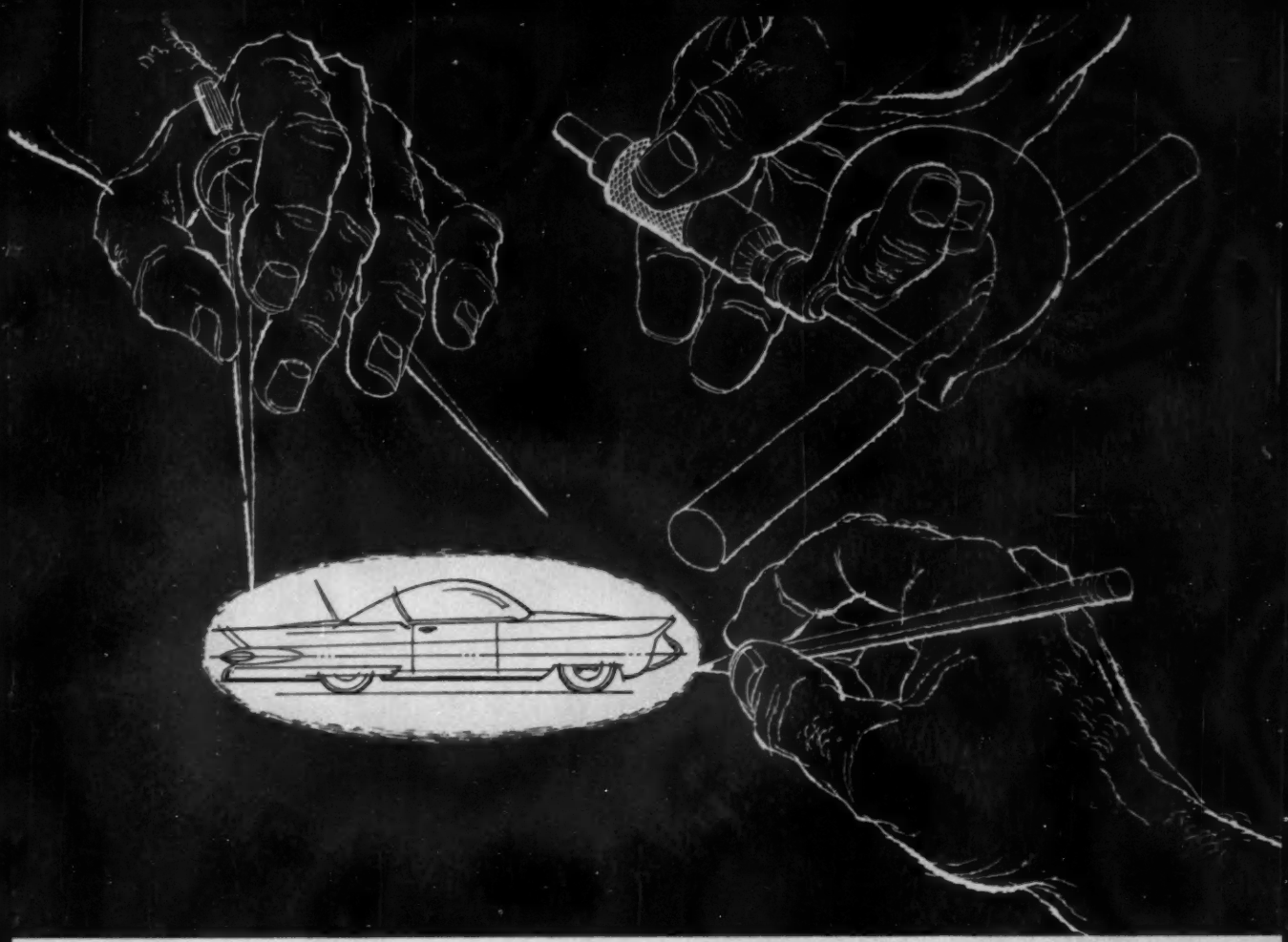
DESIGNING *for Emergency Braking?*

THE NEW HIGH OUTPUT **ORSCHELN BRAKE LEVER** WHEN USED WITH ORSCHELN CABLE MAKES POSSIBLE AN EMERGENCY SYSTEM THAT WILL OPERATE SERVICE BRAKES ON AIR SYSTEMS THROUGH EQUALIZERS. GIVING LESS THAN 100 FT. STOPS AT 35 M.P.H. ON 72,000 G.V.W. WHEN THE LEVER IS APPLIED MANUALLY.

ORSCHELN ENGINEERS WILL INSTALL PILOT MODELS FOR TEST PURPOSES AT YOUR FACTORY FREE OF CHARGE.

ORSCHELN BRAKE LEVER MANUFACTURING CO.

MOBERLY, MISSOURI



Teamwork . . . and Automotive Progress

In the automotive industry, teamwork speeds progress. Teamwork of individuals. Teamwork among design, engineering and production departments. Teamwork between car maker and components manufacturer.

Working together with the automotive industry is a Borg-Warner tradition which has resulted in many milestone contributions to automotive progress.

Today, as for many years, 19 of the 20 makes of cars—as well as trucks, buses, tractors and off-highway vehicles—contain essential B-W parts. These include automatic and standard transmissions, clutches, torque converters, radiators, oil coolers, gears, timing chains, universal joints, carburetors, differentials and other components.

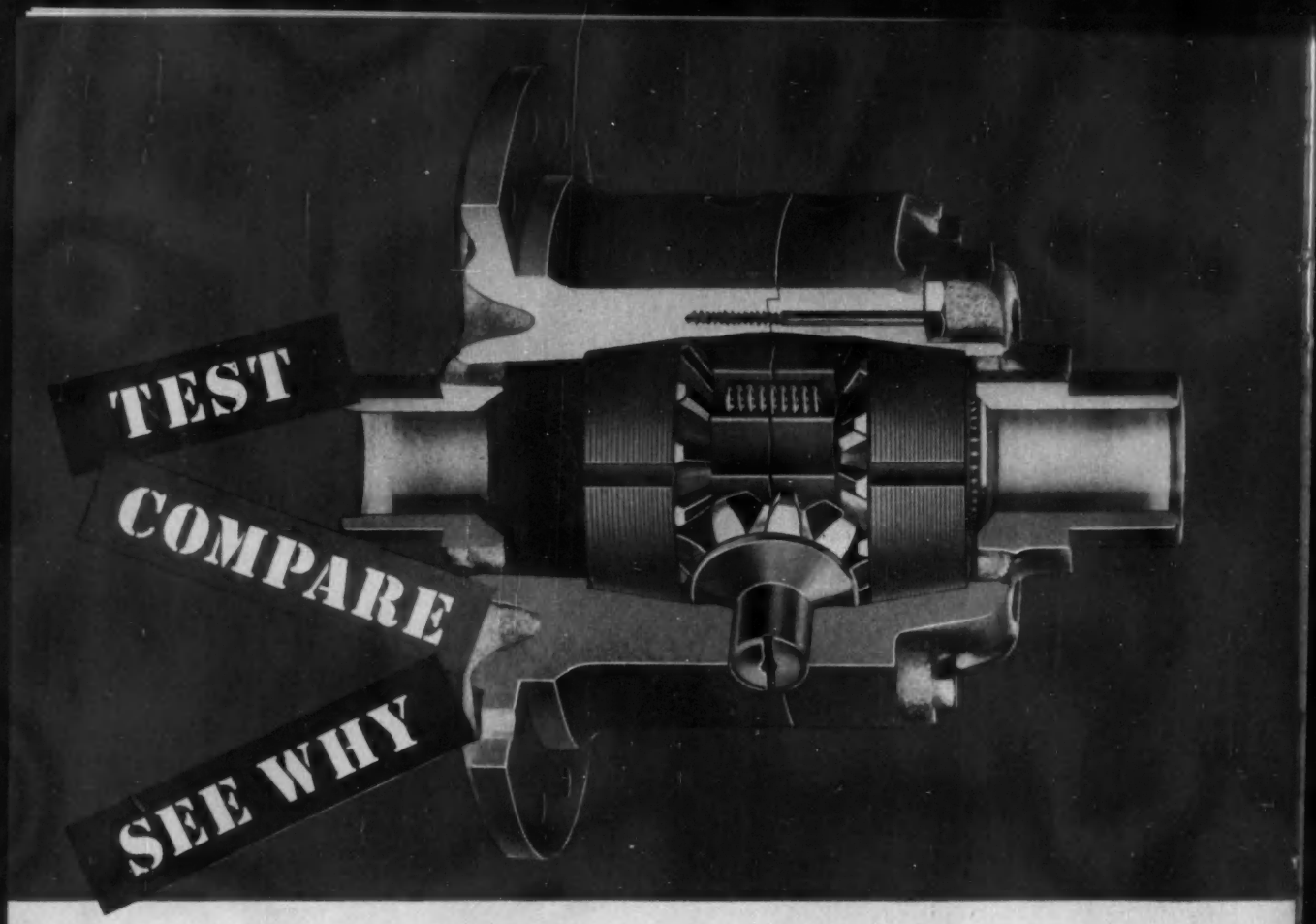
New B-W automotive products are in development stages or undergoing tests. And back of each is the Borg-Warner aim "design it better—make it better"—to assure dependable product performance and continuing automotive progress.

Whenever you have a need for B-W's special skills and experience, consult our engineers without obligation.

DESIGN IT BETTER B-W *MAKE IT BETTER*

BORG-WARNER®

200 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS



WARNER SPIN-RESISTANT DIFFERENTIAL

Gives Superior Performance

No matter what the weather or road condition—rain, snow, ice, sand, gravel, mud—the new Warner Spin-Resistant Differential keeps cars on the go. With power automatically transferred to the wheel with the greater traction, *pre-loaded* cone brakes and side gear thrust smoothly brake the other wheel.

That virtually eliminates wheel spin, greatly reduces dangerous skids and swerves, ends tire scuffing from wheel bounce. And that means sure-footed driving for cars, trucks, fork lifts and other vehicles.

Equally important is what the Warner Spin-Resistant Differential WON'T do. It *won't* become noisy, *won't* cause full locking of either axle shaft, *won't* interfere with normal steering, *won't* develop excessive backlash.

That all adds up to better, more dependable performance, greater user satisfaction. Why not see for yourself. Write, wire or telephone for full information.

Retards wheel spin for better traction

Reduces skidding, swerving

Ends tire scuffing from wheel hop

See our Displays at Milwaukee Auditorium, Rooms 1-2-3—Sept. 8-11.

WARNER AUTOMOTIVE B-W BORG-WARNER

WARNER AUTOMOTIVE

Warner Automotive Division, Borg-Warner Corporation

AUBURN, INDIANA

EVERY BORG & BECK CLUTCH
MUST "WALK A STRAIGHT LINE"
TO ASSURE PERFECT BALANCE

Probably the most important single quality in a clutch is *balance*—because balance means smoothness of operation, not only of the clutch but of the engine as well.

That's why Borg & Beck clutches are checked for balance, at operational speeds, on specially designed test machines. Even the slightest unbalance is instantly detected and carefully corrected. Perfect balance is assured, as shown above, when the electric beam of the oscillograph is vertically straight on the calibrated screen. And every Borg & Beck clutch must "walk this straight line" before it passes inspection.

This is typical of the extra care that goes into every step in the making of Borg & Beck clutches. It is your assurance of top quality, top performance, top value.

BORG & BECK CLUTCH · THE STANDARD ·

Reg. U.S. Pat. Off.

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BORG & BECK®

THE AUTOMOTIVE STANDARD FOR MORE THAN 40 YEARS

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Export Sales: Borg-Warner International, 36 S. Wabash, Chicago 3

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BORG-WARNER INTERNATIONAL—foreign operations, overseas licensing and export for all Borg-Warner products.

BORG-WARNER, LTD. (England)—automotive timing chains and sprockets. Overdrives and automatic transmissions.

BORG-WARNER SERVICE PARTS—U. S. distribution of automotive service parts.

CALUMET STEEL—special automobile jack bar steel; small angles for auto seats.

FRANKLIN STEEL—spring steel bumper supports; special automobile jack bar steel; small angles for auto seats.

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MARBON CHEMICAL—adhesives for bonding rubber and synthetic rubber to metal and other materials; high impact thermoplastic resins.

MARVEL-SCHEBLER PRODUCTS—carburetors for military and industrial equipment and farm tractors; LPG carburetion systems; automatic transmissions; fuel injection systems.

MECHANICS UNIVERSAL JOINT—universal joints and propeller shafts for cars, trucks, buses, aircraft, tractors, farm machinery, road machinery and mining machinery.

MORSE CHAIN CO.—automotive timing chains and sprockets.

MORSE CHAIN OF CANADA, LTD.—automotive timing chains and sprockets.

ROCKFORD CLUTCH—spring-loaded and over-center clutches for cars, trucks, tractors, road-building, earth-moving and oil field machinery, industrial machinery, agricultural implements, machine tools; power take-off and gear reduction units for gasoline and diesel engines; full power-shifting transmissions for earth-moving and construction equipment.

SPRING DIVISION—torque converter parts and sub-assemblies; sprag type free wheeling clutches; special clutch plates and parts for automatic transmissions; precision flat and Belleville type springs; multislide and punch press stampings, plain and heat treated; special commercial heat treating; small electric motor commutators.

WARNER AUTOMOTIVE—gear boxes; transmission gears, ring gears and pinions; spin-resistant differentials; differential parts and assemblies; splined shafts; power train assemblies; automotive replacement parts.

WARNER GEAR—standard and automatic transmissions; Overdrives; synchronizer assemblies; parking brakes; automotive and aircraft gears; marine and industrial transmissions.

WARNER GEAR CO., LTD. (Canada)—synchronizer units for cars and trucks.

YORK—compressors for automotive air conditioning; refrigeration for trucks.

B-W skill and ingenuity also benefit almost every American every day through many other fields, including:

Aviation—commercial and military aircraft and missiles contain vital B-W parts.

Nucleonics—B-W designed parts are at work in almost every U. S. reactor.

Home—millions of homes use B-W building materials, equipment and appliances.

Farm—9 out of 10 modern farms use B-W equipped machines.

Oil—every oil field has B-W equipment.

DESIGN IT BETTER ENGINEERING B-W PRODUCTION *MAKE IT BETTER*

Borg-Warner®

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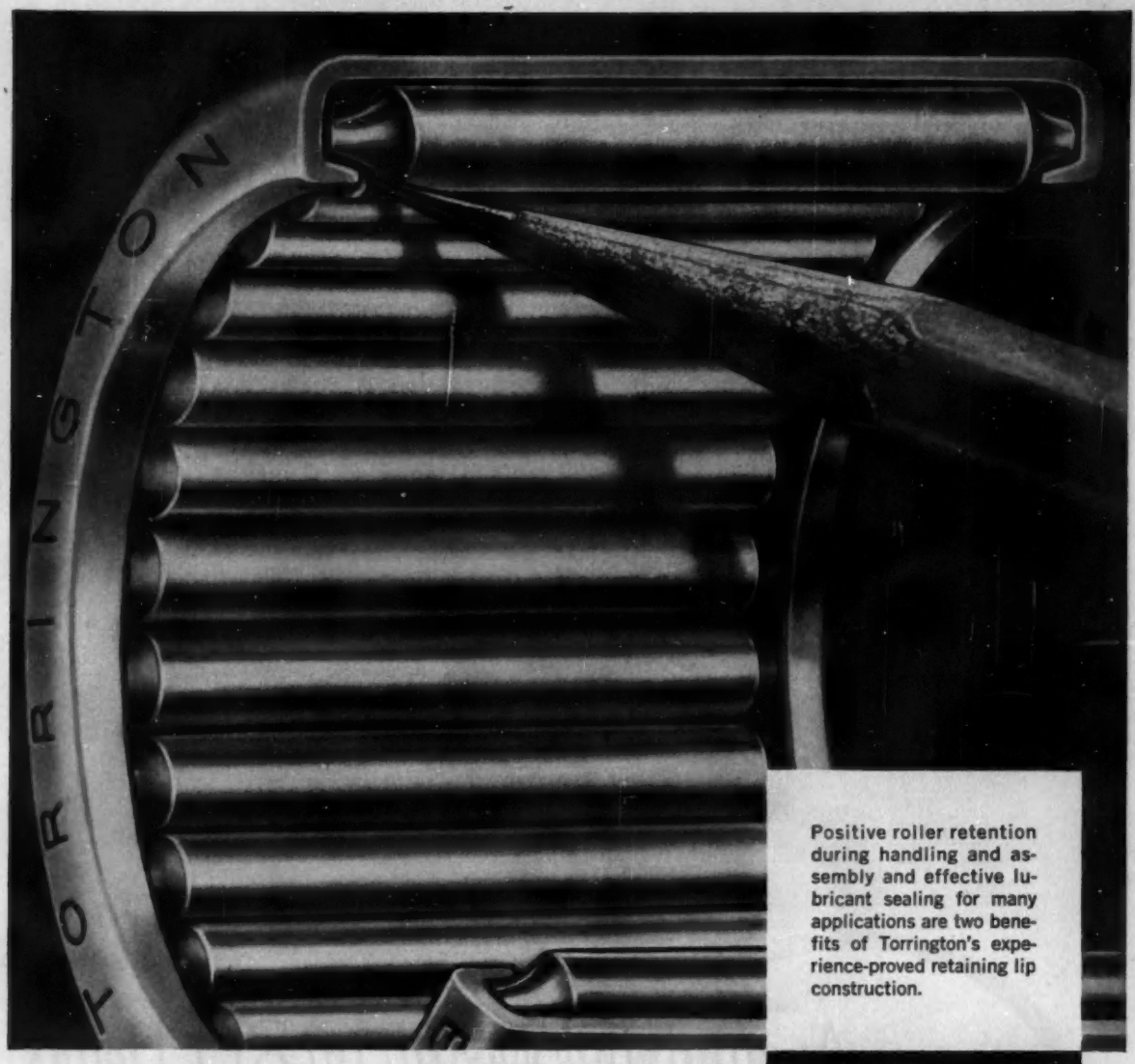
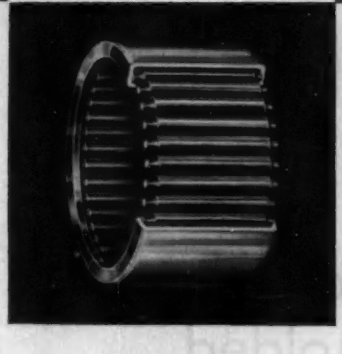


Positive roller retention during handling and assembly and effective lubricant sealing for many applications are two benefits of Torrington's experience-proved retaining lip construction.



This little lip makes a big difference!

The turned-in lip at each end of Torrington Needle Bearings positively retains the trunnion - end rollers and makes the bearing truly a complete unit, with no possibility of roller fall-out.

This unit construction simplifies installation and servicing. The closely controlled clearance and the large area between cup lips and shaft form an effective labyrinth seal. Also this retaining lip allows pregreasing the bearing with the proper lubricant for each application.

Long experience with the Torrington Needle Bearing in thousands of applications has proved the merit of this and other features in efficient performance and long service life. Make sure *your* product benefits from the best that experience has to offer—specify Torrington Needle Bearings. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE · SPHERICAL ROLLER · TAPERED ROLLER · CYLINDRICAL ROLLER · NEEDLE ROLLERS · BALL · THRUST

Around the World in 80 Years

. . . plastics parts molded by Consolidated, that is. In every part of the globe — from Scranton, Pennsylvania to Sidney, Australia — people are using and enjoying products made more dependable by components from Consolidated. Now, with two plants working for you in Scranton, Pennsylvania, and one in Binghamton, New York, we are better prepared than at any other time in our 80 year history to take care of your requirements.

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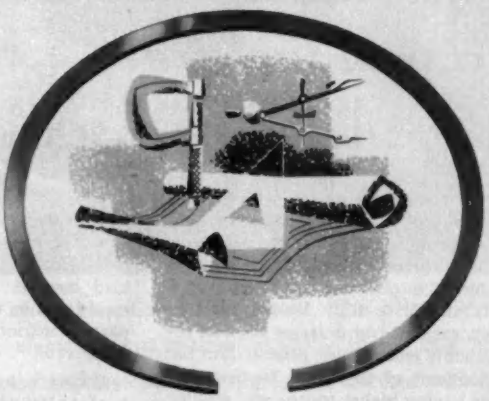
IF YOU are interested in learning more about injection and compression molding by Consolidated, send for our new, fully illustrated company brochure. Write to: Consolidated, 340 Cherry Street, Scranton 2, Pennsylvania.

RING DESIGN

to keep up

with your

engineering progress



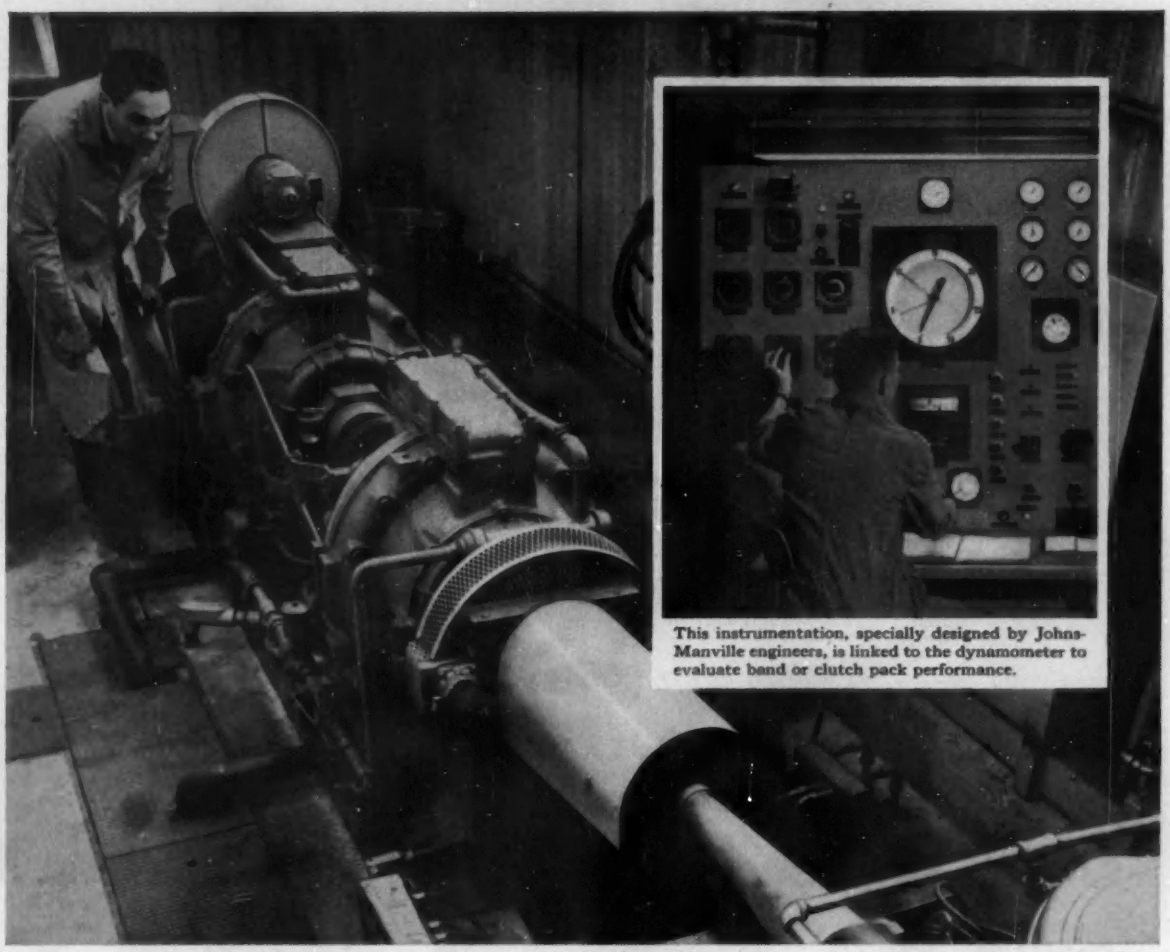
For forty-eight years McQuay-Norris has helped automotive designers convert ideas into reality.

For ring design service that always measures up to your needs, call on us.

McQUAY-NORRIS

MANUFACTURING CO. **St. Louis • Toronto**

Largest Producer of Small Rings in the Automotive Industry



This instrumentation, specially designed by Johns-Manville engineers, is linked to the dynamometer to evaluate band or clutch pack performance.

No pull too great... no hill too steep

to duplicate on this test equipment designed to evaluate J-M Transmission Band Linings

IN ITS SEARCH for better friction materials for use in automatic transmissions, Johns-Manville follows advanced scientific test methods. Versatile machines, capable of duplicating the inertia of a sports car or a fully loaded tractor-trailer, explore transmission friction requirements and furnish precise data for development of improved friction materials having higher torque and greater durability.

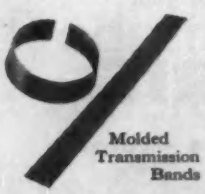
The test machine, shown above, is a 600-h.p. dynamometer with a rated torque of 3500 lb-ft and capable of holding even the largest engines and transmissions. When coupled to an engine, the dynamometer and its inertia flywheel can operate on torque, speed or load control. It can simulate service conditions in the transmission where a particular friction material was designed to operate.

Accurate performance data is automatically recorded by electronic instrumentation that reads torque, temperatures, transmission control pressures, output shaft and engine speeds, plus other useful data.

J-M engineers exercise the same exacting care in the testing and production of all friction materials. When you have a special problem involving automatic transmissions, clutch or brake assemblies, they'll help you find the solution. Write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE PRODUCTS



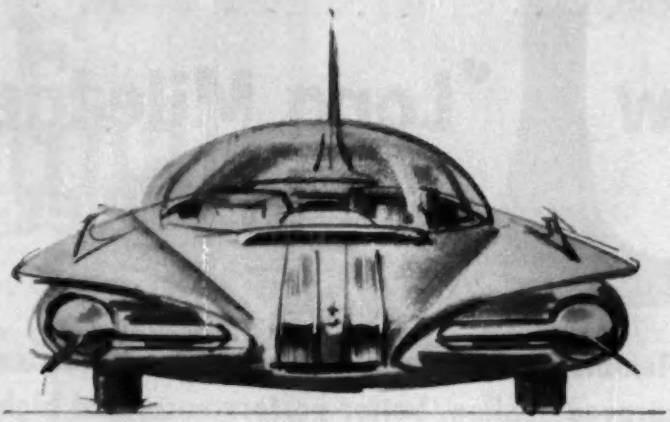
Molded Transmission Bands

Friction Discs

Molded and Woven Clutch Facings

Molded Brake Blocks

Molded and Woven Brake Linings



PUROLATOR'S DRY TYPE AIR FILTERS GIVE COMPLETE DESIGN FREEDOM

With Purolator's new dry type air filters, there's no need to keep a constant, level bearing . . . to set the air cleaner on top of the block. There is no oil to spill, no level to be maintained. This makes it possible to place the filter anywhere at all . . . under the engine, on the side . . . wherever it allows the most design freedom.

Of course, the big advantage in dry type filtration is the optimum efficiency it affords. The Micronic dry type element is just as effective at low speeds as at high speeds. And instead of becoming less efficient with use, its already outstanding 99% efficiency *increases* to 99.7%.

Design your cars the way you want them . . . then call on Purolator to design and produce the air filter to fit your design.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

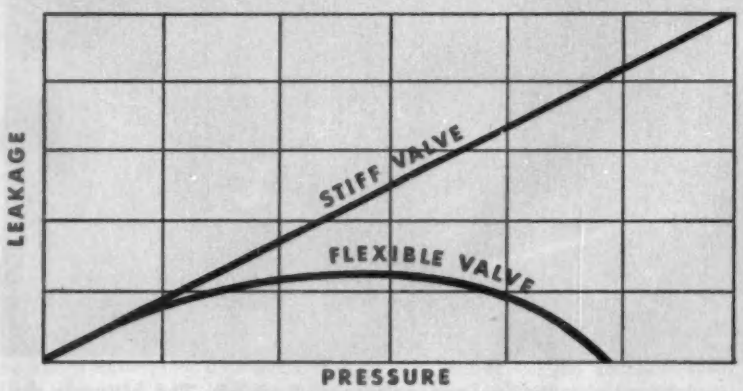
The New "Long Mileage Look" in Valves

Flexible design and high strength materials can provide improved sealing, better performance, and higher mileage

The higher outputs, greater load factors, and lean mixtures encountered in modern engines are all making greater demands on valves. By utilizing high hot strength materials, valves may be designed that flex from cylinder pressure and tend to conform to a distorted cylinder seat. The result can be greatly improved sealing, maintained engine performance, and higher mileages.

Eaton engineers welcome an opportunity to discuss your valve problems with you.

Typical seat condition in stiff valve, caused by imperfect sealing. Result: poor performance, low mileage.



Leakage Test on Distorted Cylinder Head Seat: With stiff valves, leakage increases in direct proportion to cylinder pressures. With flexible valves, leakage is reduced to zero when cylinder pressure increase produces valve conformity.

Typical flexible valve under comparable operating conditions. Result: Improved sealing assures better performance and longer mileage.

EATON

VALVE DIVISION
MANUFACTURING COMPANY
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For The Sake of Argument

FIRST Thoughts . . . .

By Norman G. Shidle

A practical corollary to "Our consciousness is our life" is:

> "What we see *first* is as important as what we take into consciousness in toto."

The subject or the situation doesn't matter much. It may concern human relations, or the weather, or anything in between.

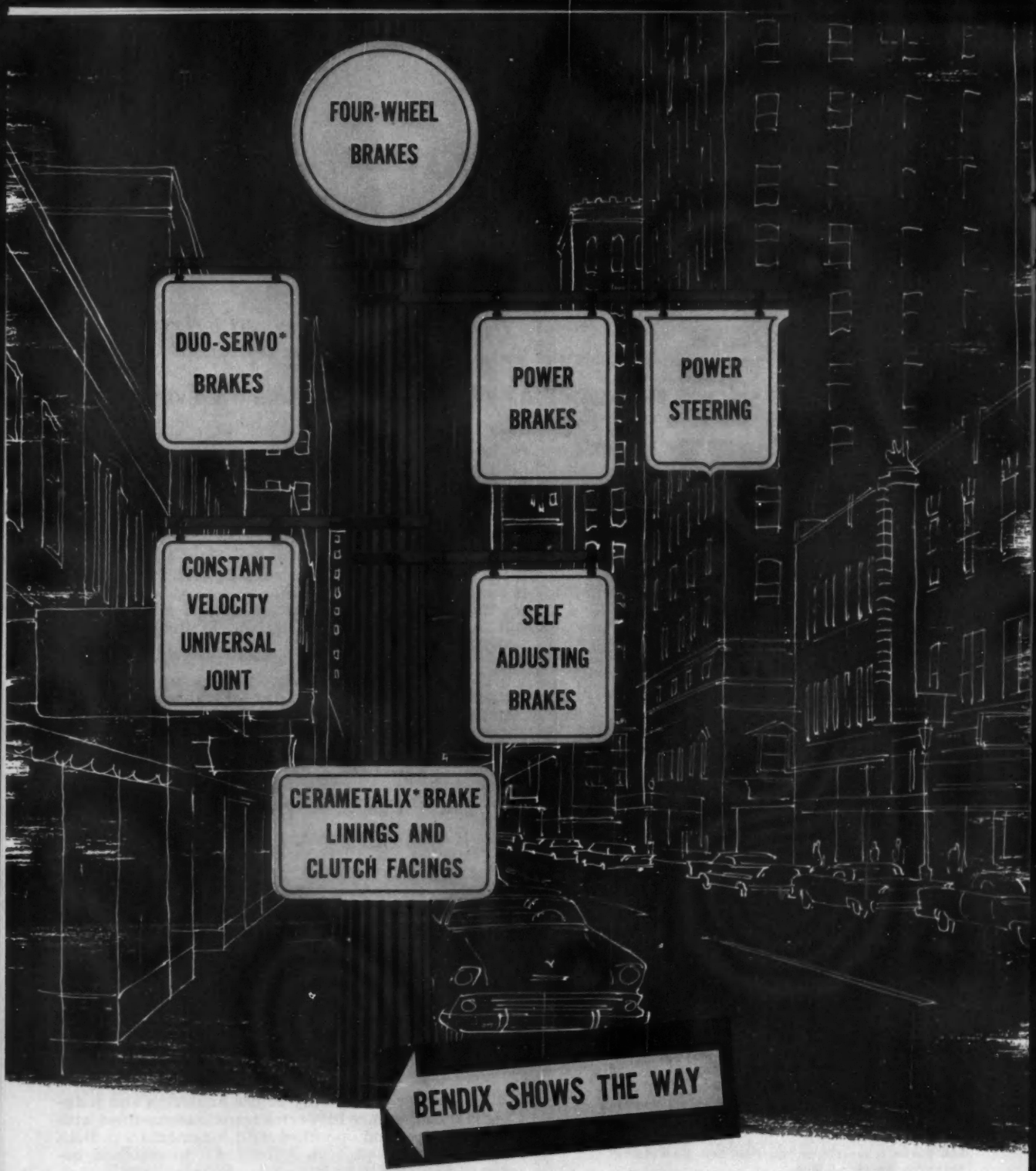
The chap who, wakening up to a rainy morning, thinks *first* "This is a great day for transplanting flowers" is automatically looking for opportunity. Non-participating judgment would first make him conscious of what the rain prevented him from doing.

Or, take the situation noted by Harvard Business School's Malcolm P. McNair in "What Price Human Relations?":

> "Between acceptance of high moral principles and the exigencies of day to day conduct of affairs there can be, with the best of intentions, a very wide gap . . .
>
> "No long-run contribution to the development of good people (in business) will be made unless the good individuals personally take the responsibility for developing other individuals."

Developing other individuals, as it were, is the opportunity. Alone, criticizing and judging would be non-participating. But, positioned in the framework of "opportunity" consciousness, both contribute to development.

Looking for opportunity *before* analyzing and judging is the difference between a consciousness filled with opportunities and one filled with judgments. . . . Both are important — but so is the order in which it becomes natural for us to look for them.



Each of these key Bendix developments has had an important influence on the course of automotive design. New Bendix developments now in process demonstrate continuing foresight into the needs of the automotive industry. Let us consult with you now on problems relating to your future.

*REG U.S. PAT. OFF.

Bendix PRODUCTS DIVISION South Bend, IND.

Bendix AVIATION CORPORATION

chips

from SAE meetings, members, and committees

INFLATING AIRPLANE TIRES with nitrogen instead of air protects them from the damaging effects of nuclear radiation.

•

SMALL CARS, lawnmowers, military communications systems, and other common devices may some day be powered by fuel cells turning hydrogen and oxygen directly into electricity.

Cells consist of porous carbon electrodes in a sealed container holding a solution of potassium hydroxide as the electrolyte. Hydrogen and oxygen enter the cell through the hollow electrodes and diffuse to the electrolyte. At the hydrogen electrode, the electrochemical reaction with the potassium hydroxide produces water and releases an electron that enters the electrical circuit. The electron flows through the external circuit, and returns to the cell at the oxygen electrode, where in the electrochemical reaction of the oxygen and electrolyte, the electron is accepted. Ionic conductivity through the electrolyte completes the circuit.

Air provides the oxygen. Possible sources of hydrogen include, calcium hydride, ammonia, coal, and catalytic cracking of petroleum.

SAE members who have sought information on the fuel cell's performance may be interested to know that National Carbon researchers who developed the cell estimate that a 65-lb battery pressurized to five atmospheres could produce 90 amp at 11.2 v. It would occupy 2/3 cu ft. (Fuel supply is additional.) A wide range of sizes is practical.

•

FUEL CELLS may also aid in utilization of solar and nuclear energy. During sunny periods, the energy of the sun could be used to decompose water into hydrogen and oxygen for later use in fuel cells. Nuclear energy can decompose water, too. In present nuclear plants in which the reactor serves only as a source of heat in the conventional steam cycle, this decomposition is purposely prevented. But for use with a fuel cell, decomposition could provide hydrogen and oxygen for fuel cell operation.

•

NOISE SUPPRESSOR that will be used on the production DC-8 evolved as a result of a testing program that investigated 500 variations of sound-reducing devices at 10% scale, 350 at 20% scale, and 38 types at full scale.

•

"BLUCKETS" is what G. E. engineers are calling the blades of the turbofan added to make a bypass version of the J-79 turbojet engines. A blucket is really a compressor blade whose base is integral with the shroud of a turbine bucket. The buckets form an inner ring that takes energy from the gas leaving the main turbine rotor, and powers an outer-ring compressor, which compresses secondary air that has bypassed the main compressor and burner.

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WHEN AMERICAN MOTORS' "METROPOLITAN" was first developed, the engineering of the entire vehicle including body surface developments was done in Detroit. Then the drawings were sent to England where the prototypes were built to take advantage of lower cost of engineering and tooling abroad. . . . Then the cars were shipped back to the United States for testing. U. S. Customs promptly prorated to each car the engineering work previously done by American engineers and included that proration as part of the dutiable value of each car. An import duty had to be paid on work done in United States by American engineers.

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ALUMINUM ENGINES will require a new look at the cooling system. Rust will be gone, but corrosion may take its place if the right combination of inhibitors and radiator material is not used.

Any aluminum oxide formed in the system will give designers a new problem — larger passageways. The oxide is flocculent and will plug small tubes as fast or faster than rust.

When designers settle on the alloys of aluminum to be used in these new engines, the corrosion experts will have to take over to match them to the other materials in the system.

•

GAUDY PAINT JOBS on aircraft are proving to have an important secondary advantage: Not only can the airplane painted with the new fluorescent paints be seen better by other pilots, but also ground controllers see aircraft in the traffic pattern at a greater distance. Therefore, they are better able to provide adequate clearance.

Since USAF Air Training Command has been using paint that glows on its primary and basic trainers, incidence of mid-air collisions has dropped from 7–9 per year to 2 — and those two aircraft hadn't been repainted with the new glowing paint. Cost of painting 2000 aircraft is said to be less than one-third the cost of one aircraft.

Design do's and don'ts for the coming . . .

All-Aluminum V-Type

Based on paper by

James M. Smith and Richard M. Smith
Aluminum Co. of America

ALUMINUM engines are on the way because they promise a gain in power-weight ratio and possibilities of production economies. Aluminum has already proved its value for some parts; only the adaptation of design for high production methods delays full realization of the metal's potentials.

Here are pointers for selecting the proper casting process

- For thin sections die casting is preferred.
- Use permanent-mold process for thicker sections to gain strength, rigidity, and soundness.
- If neither die-casting nor permanent-mold process is suitable, try the semi-mold or sand-mold process.
- Designs for sand casting are similar for iron and aluminum. Customary allowances hold for core shifts and finish.
- Permanent-mold and die castings require smaller allowances than sand casting. Broken or washed cores are eliminated. Cores are not expendable so part must be designed without backdrafts or undercuts. Cores must retract and part be ejectable from mold or die.
- Where backdrafts and undercuts are avoidable in permanent-mold casting, collapsible cores can be used, but employ such design as last resort for sake of economy. Pressure used in filling die in sand casting would develop fins between collapsible cores. Adding loose cores to produce undercuts would increase cost and retard cycle.
- The semi-mold process, using a multipiece iron mold and dispensable cores, promise high production for castings having conventional crankcase geometry. Easily removed and economical core materials are being developed.

The integral sleeve and cylinder block construction found on all American cars can be produced in sand with aluminum as well as with iron. The aluminum crankcase, as currently produced in sand for dry-liner installation, cannot be made by permanent-mold or die-casting methods because the top deck prevents withdrawal of the metal water jacket core (Fig. 1). But removal of this top deck and integral cylinder wall and substitution of an insertable wet liner would make the design practical for either permanent-mold or die-casting methods.

Feasible Crankcase and Block Design

Two satisfactory liner arrangements (Fig. 1) are shown in which the upper end of the cylinder is closed by a plate into which is inserted, in one case, a liner with a shoulder resting against the plate. An alternate construction has been advocated in which the liner is brazed into the cover plate. With an all-aluminum engine, an aluminum plate, rather than an iron or steel one, would do a better job of equalizing the expansion of the top and bottom portions of the crankcase. Aluminum liners may be assembled into this plate by known methods. The stiffness of this cover plate must be adequate to sustain the gasket load on application of the cylinder head. The liner in construction "A" and "C" should extend 0.002 to 0.005 in. above the cover plate to produce an effective seal against combustion pressures.

Fear of water leakage often has prevented adoption of such wet-liner construction. The cylinder center distance in the conventional iron engine without liners is less than that of a wet-liner engine of the same bore. In an aluminum engine with liners (Fig. 1) this difference in center distance is reversed and that distance may be even smaller with a wet liner than with a dry one. The figures used are for a 4-in. bore current production engine. On the basis of a comparative design, the cylinder center distances are approximately 4 11/16 in. and 4 9/16 in. for wet-liner construction "A" and "B", respectively, as opposed to 4 13/16 in. for a dry-liner, sand-cast aluminum engine.

Construction "C" in Fig. 2 shows sections for the conventional dry-liner, sand-cast engine of 4-in. bore. The elimination of the top cylinder deck in construction "B" permits the metal jacket core to be withdrawn from the casting. Water seal at the top is accomplished by a conventional cylinder-head

Engine

gasket. Construction "A" is similar to "B" with the application of a top plate into which the liners are inserted. Both constructions require a center distance of 5 3/16 in., which is 3/8 in. greater than the minimum sand-cast engine.

Treatment of the outside lower edge of the liner is important (Fig. 2). Its purpose is to avoid scoring of the aluminum bore during assembly of the dry liner with a recommended fit of 0–0.002 in. A similar treatment is advocated for wet-liner construction to permit easy insertion of the liner past the rubber seal rings. Application of a mild soap solution will facilitate assembly.

The aluminum bores in a dry-liner engine should have a finish of 10 to 20 microin. rms. A lubricant of the colloidal graphite type will permit insertion and removal of the liners without scoring the aluminum bore.

Since conventional practice requires a liner in aluminum engines, dry-liner construction with permanent-mold or die casting calls for an engine of greater overall length. Adoption of wet-liner construction simplifies crankcase casting, speeds the operation of mold or die equipment, and reduces overall engine length.

Fig. 3 illustrates a transverse section of a basic V-type engine crankcase designed for permanent-mold or die-cast manufacture. Referenced to the plane of the pan rail, the mold or die pieces forming the sides and ends move in parallel planes, lifter chamber cores move in a perpendicular plane, while water-jacket cores move in the plane of the cylinder centerlines. The avoidance of undercuts or backdrafts frequently causes local heavy sections. This condition is indicated near the cylinder-head bolt hole, alternate "B." Relief can be had sometimes by resorting to the construction shown in alternate "A."

Multipiece Design

If hypereutectic aluminum-silicon alloys, now attracting attention, satisfy cylinder-bore wear and crankcase structural requirements, the sand or semi-permanent-mold process could be used to produce a conventional one-piece casting. The process would require elimination of backdrafts and undercuts on outside surfaces and keeping expendable water-jacket core material to a minimum.

Should these alloys not fulfill crankcase require-

Design Details of Primary Importance

(a) Blending at severe section changes.

(b) Marginal distance at bolt holes.

(c) Bolt boss diameters and threaded depth of holes.

(d) Broad, flat, low ribs in general, as opposed to narrow, round, and high, which are frequent cause of failure.

(e) Bolt fastenings located in or near supporting wall sections to minimize eccentric loading, induced bending.

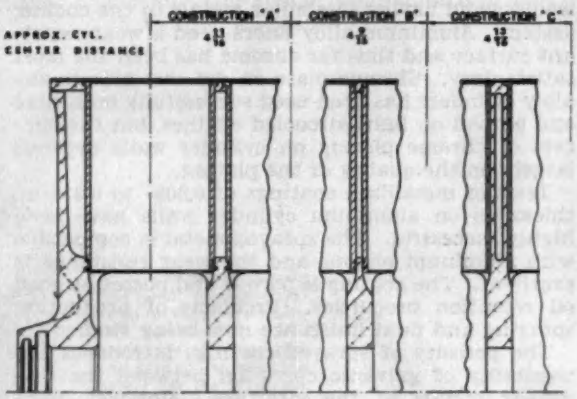


Fig. 1 — Wet- and dry-liner construction. Longitudinal sections showing influence of design details on cylinder center distances.

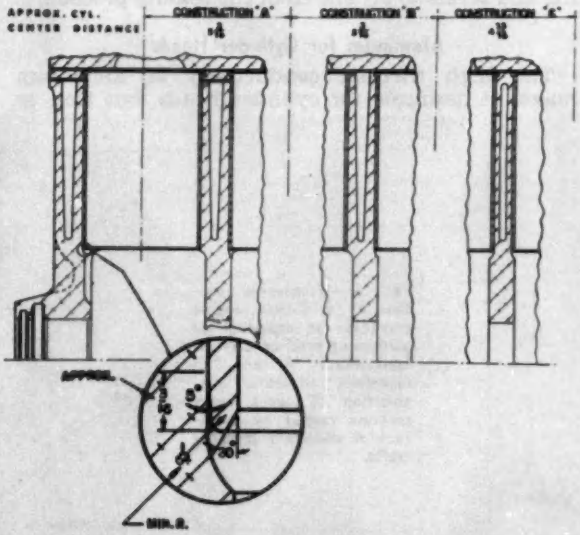


Fig. 2 — Conventional dry-liner construction shown sectionally for sand-cast engine of 4-in. bore. Note treatment of lower edge of liner to facilitate assembly without scoring of aluminum bore.

Design do's and don'ts for the coming . . .

All-Aluminum V-Type Engine

continued

ments but be suitable for the cylinder bore, then a multipiece construction is proposed. Fig. 4 suggests a possible design solution. Permanent-mold or die castings would be used with hypereutectic aluminum-silicon alloy for the block and a suitable aluminum alloy for the crankcase.

Cylinder-Liner Construction

Aluminum-alloy liners have a decided advantage over iron. In their favor can be listed weight saving, superior heat conductivity, and a coefficient of expansion identical with that of the crankcase and piston. Moreover, use of aluminum-alloy wet liners would avoid having dissimilar metals in the cooling system. Aluminum alloy liners need a wear-resistant surface and thus far chrome has been the most satisfactory. Chrome plate on die-cast aluminum-alloy cylinders has been used successfully both here and abroad on light aircooled engines, but the success of chrome plating on cylinder walls depends largely on the quality of the plating.

Tests of metallized coatings of 0.005- to 0.015-in. thickness on aluminum cylinder walls have been highly successful. The sprayed metal is compatible with aluminum pistons and the wear resistance is excellent. The coating is porous and possesses good oil retention properties. Problems of production spraying and final finish are now being studied.

The porosity of sprayed coatings introduces the possibility of galvanic corrosion between the dissimilar metals at the interface. However, tests show that moisture of condensation can be excluded by impregnating the coating with a resin dissolved in a suitable vehicle. Finish honing is done after sealing and seems to benefit from the sealing procedure.

Aluminum for Cylinder Heads

The high thermal conductivity of aluminum makes it desirable for cylinder heads, but iron or steel valve inserts should be provided with aluminum-alloy heads to withstand the impact of valve seating. To obtain the highest possible volumetric efficiency, the largest valves that can be accommodated in combustion chambers should be installed. This results in an absolute minimum bridge between valves precluding, in some cases, the installation of seat inserts. And it has spurred attempts to eliminate inserts and seat the valves directly on the aluminum. A partial solution may be to use slower cam seating ramps. Head castings of the harder high-silicon aluminum alloy may permit this simplification, together with elimination of valve guides.

When aluminum heads are used, there is a substantial reduction in octane-number requirements, as shown in Fig. 5. The aluminum and iron heads used were identical and of equal compression ratio. The curves represent trace knock requirements at full throttle using primary reference fuel. Note that this improvement is not at equal power ratings, but includes the power gains observed with aluminum heads at equal compression ratios.

The high thermal conductivity of aluminum makes the temperature distribution throughout the casting more uniform. For this reason, thermal strains are low, resulting in reduced valve-seat distortion and better gas sealing.

Cylinder heads are traditionally sand cast. The more compact the designs the more fragile and intricate the cores become. Broken or washed cores result in much foundry scrap or defective parts cause poor cooling in service. A great reduction in these difficulties would result if it were possible to produce the cored cavities by metal cores and design the head to permit withdrawal of these cores from the casting.

Intake Manifold Casting

As now designed for V-8 engines, intake manifolds cannot be made by permanent-mold or die-casting practices; the passages are too intricate to permit withdrawal of iron or steel cores. Designing multiple pieces to be resin-bonded into a complete assembly would have the effect of opening the passages and making such casting possible.

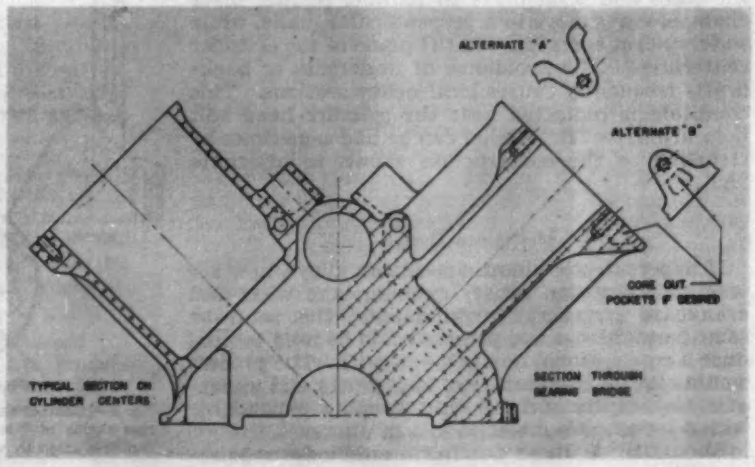


Fig. 3 — Transverse section of a V-type engine crankcase as designed for permanent-mold or die-cast fabrication. "A" and "B" represent alternate construction to avoid heavy sections caused by avoidance of undercuts or backdrafts.

The jacket water heated intake manifold, now receiving attention, relieves the problem of high temperature but adds passages to an already involved part. A cored passage under the intake port could admit hot water to heat the manifold, which would then function as a water-collecting manifold as well.

Aluminum for Bearings

The solid aluminum bearing in cast or sheet form is very attractive. Fatigue failures are practically non-existent and heat is dissipated rapidly. More clearance must be allowed because of the differential expansion between the bearing and the steel or iron shaft, if used. As a starter, clearance can be established at 0.00125 to 0.00150 in. per in. of journal diameter.

When solid aluminum bearings are used in an aluminum housing there is a problem of maintaining clearance at low temperature without exceeding standard clearances at operating temperatures. This can be mastered by using a steel backing about two gage numbers thicker than customary and selecting a parting line height which will maintain a normal crush stress at operating temperatures. The solution is a high prestress to resist the contraction of the aluminum housing with reduction of temperature.

Next month . . .

. . . another article will be published on the coming aluminum engines. It will bring to light engineers' agreement on problems; divergence on solutions.

To Order Paper No. 68A . . .
. . . on which this article is based, turn to page 6.

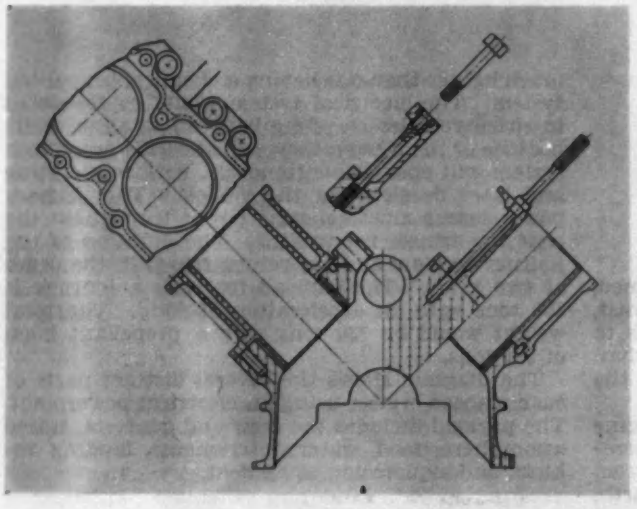


Fig. 4 — Aluminum cylinder block and crankcase assembly designed for multi-piece construction. This permits one aluminum alloy to be used for the block and another for the crankcase.

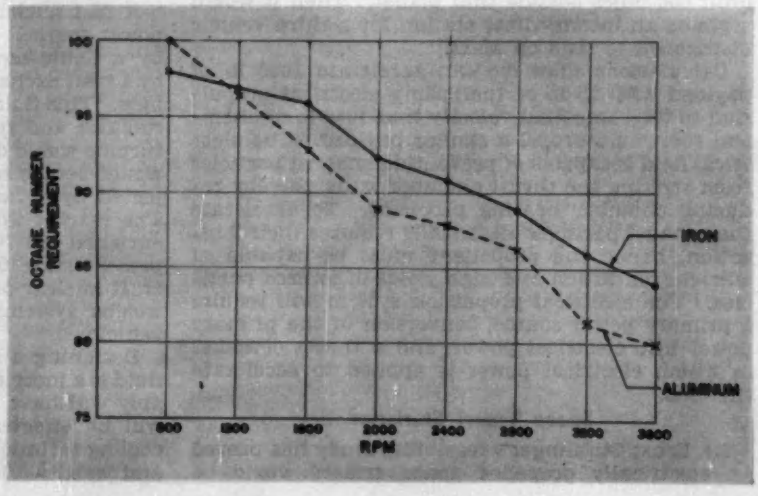


Fig. 5 — Comparison of full-throttle octane requirement for aluminum and iron cylinder heads on a 6-cyl, 3½ × 4⅜-in. overhead-valve engine.

The Ion Rocket Engine

. . . a likely power source for that trip to Mars

Based on paper by

Donald L. Eschner

Martin Co.

Abridgment of an

SAE Metropolitan Section Paper

THE ion rocket engine — in which ions are formed, then accelerated electrically to furnish thrust, and finally probably recombined with electrons to neutralize the charge — appears better suited than chemical, heated gas, or photonic rockets for the long middle step from Earth to Mars.

The accelerating ability of an ion rocket engine is meager, but the engine is light in weight. Therefore, it might propel a space cruiser, launched from a space station orbiting 1000 miles above the earth, across space to the vicinity of Mars and into an orbit 600 miles outside that planet. Then it would serve as an intermediate station for a third vehicle dispatched to land on Mars.

Calculations show we can accelerate 1000 lb of payload with 25 lb of fuel, using electrical propulsion to the same final velocity that 1000 lb of chemical fuel could propel a similar payload. The electrical field is capable of preventing exhaust particles from striking the thrust chamber walls, thereby reducing chamber heating problems. To accelerate the exhaust particles electrically requires their ionization, hence the propellant must be capable of efficient ionization and high yields of ionized particles. The electrical propulsion system will require a primary power source, conversion of the primary power into electrical power, and a thrust chamber in which electrical power is applied to accelerate the ions.

Space Travel Statistics

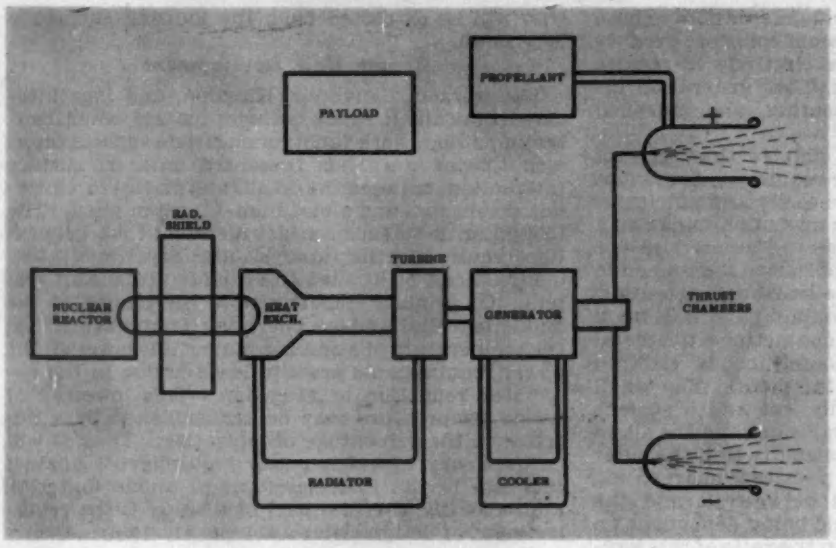
Dr. Ernst Stuhlinger's feasibility study has proved an electrically propelled space cruiser would be much lighter than one having a chemical propulsion system. The electrical system would be restricted to space vehicles traveling between satellite orbits because of the inherent low thrust. This propulsion system will operate continuously, first accelerating and later decelerating the vehicle. The primary power source must generate power throughout the time the cruiser is traveling. The duration of the journey to Mars and the return trip is in the order of two years. The payload for such a journey is 150 tons with an acceleration of $10^{-4}g$. The total weight would be 730 tons with a propellant mass of 365 tons.

The diagram shows the several distinct parts of such a space cruiser using an electrical powerplant. The payload includes the crew and quarters, stored atmosphere, food, water, instruments, landing vehicle, and exploration equipment.

Primary Power Source

A fast nuclear reactor is chosen for the primary power source. The reactor heat would be absorbed by a liquid-metal cooling system and transferred by a heat exchanger to a working fluid driving a turbine. This fluid would be cooled by means of a large radiator and returned to the heat exchanger. The turbine would drive an electric generator which also would be cooled by liquid metal with the heat rejected by a radiator and the coolant recirculated. The reactor would contain 12 tons of uranium 235 enriched to 1.7%. This type of reactor is within the present state of the art knowledge. Work on aircraft nuclear powerplants is being focused on lightweight systems which are critical for the space vehicle.

Designing a radiator to cool the heat exchanger fluid is a more difficult problem. The radiator probably will have a large surface area since heat loss will be effected solely by radiation. Evaporative cooling techniques may be used to minimize the size and weight. This problem boils down to a design



ESSENTIAL COMPONENTS of an electrically propelled space cruiser for flight from an orbiting space station 1000 miles from the Earth's surface to an orbit 600 miles from Mars (the second stage in a 3-stage flight). The payload includes crew and quarters, stored atmosphere, food, water, instruments, landing vehicle, and exploration equipment.

optimization study and conventional methods will be employed.

Currently, we are cooling airborne electronic equipment by evaporative techniques and getting significant weight savings thereby. The fact that space vehicle flight will be in a near perfect vacuum may prove advantageous to a sublimative cooling system where heat exchange is performed by expelling vapors from a sacrificial material having a high latent heat of sublimation. This sacrificial material may be the fuel which is to be vaporized.

Problem of Control

Control will be accomplished by gimbaled thrust units. As the acceleration is very low, response of this type of control system does not appear critical, hence the crew can guide, relying on star tracking to navigate. Guidance and control do not appear to be as serious a problem for the space vehicle designer as they are for current ballistic and guided missile developments.

Thrust unit development seems to constitute the most significant problem. The electrical propulsion concept, which is attractive because it lies within present technical capabilities, is capable of providing thrust for long periods and is more economical from a weight standpoint than a chemical system. Specific impulses for ionic propulsion systems are 20–50 times greater than those of chemical rockets, although the first trip to a celestial body probably will be made with a chemically propelled vehicle. An electrical system can be developed relatively soon which will prove to be more practical than all other systems and will replace chemical systems in long-duration space flight.

Ion Generation

Positive ions can be generated by a variety of methods such as canal rays, capillary arcs, radio

Space Vehicle for a Trip to Mars

Drs. Werner Von Braun and Ernst Stuhlinger have advocated using three separate vehicles for travel to Mars. The first of these, a conventional liquid- or solid-fueled, 3-stage vehicle, would escape from the Earth's atmosphere and terminate at an orbiting space station 1000 miles from the Earth's surface. The second vehicle, a space cruiser, would leave the satellite orbit and enter an orbit 600 miles above Mars. The third, or landing, vehicle would be detached from the space cruiser, reduce its orbiting speed by rocket power, and enter a downward trajectory through the Martian atmosphere.

On the trip back, the landing vehicle would return from Mars to the orbiting cruiser. The crew would transfer and fly to the Earth's satellite. The final hop to the Earth would be made in the crew-cargo portion of the third-stage rocket which made the trip from the Earth to its satellite.

The space cruiser would have to be assembled at the orbiting space station. And due to the large investment in fuel for the commuter rockets to transport the component parts for both the space station and the cruiser, light-weight construction is an absolute necessity. The largest part of the space cruiser's weight will be represented by fuel, hence the investigation of a suitable propulsion system is imperative.

frequency, and magnetic field augmentation. These methods depend on electron-atom collision, producing a plasma with a negative electrode to remove positive ions. Other methods of ion generation include photoelectric effect, heating, and chemical reactions.

The Langmuir method is simpler than any of those mentioned and its power requirements are low. Atoms of the alkali metals are easily and efficiently ionized. The gaseous metal is made to impinge on a heated metallic surface, where the atoms lose one electron. The probability of ionization is assumed to be as high as 90% because the ionization potentials of the alkali are low and the contact potentials high.

A neutral alkali metal atom contacting a hot metal surface will share its most loosely bound electron with the conduction band of the metal. The alkali atom's identity is momentarily lost and a surface alloy is formed. The base metal is hot and the alkali ion evaporates with a high probability that the outer electron is left behind. The positively charged ion creates an electrostatic field between it and the metal, the strength of this field being dependent on the ionization potential. When the ratio of this ionization potential to the work function of the ionizing surface is low enough, the probability that an electron will be extracted from the ionizing surface is very small.

Thrust Unit Development

The work of Langmuir, Kingdon, and Ives indicated that alkali vapor becomes ionized when contacting a high work function electrode such as tungsten. Later work has presented data on surface interactions between the alkalis and platinum, oxygenated tungsten and a platinum-tungsten alloy. The Langmuir or surface contact method of ion generation requires further analysis and experimentation before it can be applied to an ionic propulsion system. Of primary importance is the choice of the anode material and its operating temperature. As the temperature of a specific material is lowered, the power requirements are also lowered due to the associated reduction of radiation. This lowering of anode temperature may be accomplished by a decrease in the percentage of ionization. Thus, it will be necessary to weigh power requirements against fuel loss in the final selection of anode material. Consequently, the first part of a study is the establishment of design criteria for the anode.

To Order Paper No. S98 . . .
. . . on which this article is based, turn to page 6.

Variable-Geometry Inlet . . .

. . . makes it possible for a supersonic aircraft to obtain near-optimum net thrust at all Mach numbers.

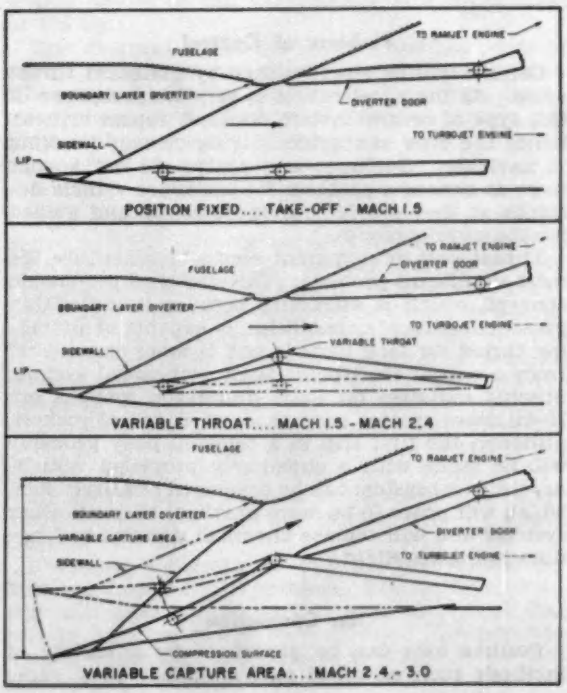
Based on paper by

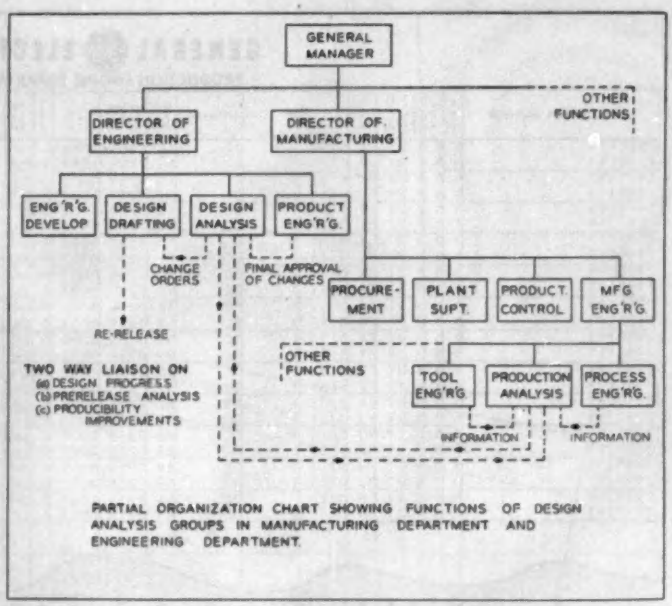
James H. Maravel and John Lyttle
Republic Aviation Corp.

VARIABLE geometry of this inlet, designed by Republic Aviation, made possible the attainment of a high supersonic speed with sufficient fuel reserve to accomplish a mission. Fixed inlet geometry would have seriously reduced the acceleration thrust of an aircraft depending solely on air-breathing engines. It would also substantially increase fuel needed for acceleration.

A bleed door downstream of the subsonic diffuser bypasses unneeded air overboard. This bypass is necessary for good inlet-engine matching, despite the capability for independent variation of throat and capture area.

To Order Paper No. 498 . . .
. . . on which this article is based, turn to page 6.





PARTIAL ORGANIZATION CHART SHOWING FUNCTIONS OF DESIGN ANALYSIS GROUPS IN MANUFACTURING DEPARTMENT AND ENGINEERING DEPARTMENT.

10 ways to cut

Missile Production Costs

Based on paper by

Conrad D. Bliss

Bendix Products Division—Missiles, Bendix Aviation Corp.

MISSILE making has suffered from extremely high production costs because of carry-overs from aircraft manufacturing and the absence of long production experience. Even with these two strikes against him the production manager can cut costs. He does this by working as a partner, not a follower of engineering, and by sticking to production rather than tool-room techniques.

Granting that lot sizes are going to be small and engineering changes will continue to come through, here are some of the steps open to the production department.

(1) Freeze design earlier and then use a block-change-system for all but extreme emergency changes. This way several changes are made as a group and at one time.

(2) Don't accept without question the idea that long operating life will give any greater reliability for the short life expected. The requirements for long "shelf" life should not be confused with reliability during the mission.

(3) Stop routine use of tolerances printed in the corner of the title block. Production costs, in most cases, are many times greater than any benefits derived.

(4) Evaluate the effect on total cost of using more tooling, even on short runs. Hand-in-glove with this is a tooling design that gives a low setup time.

(5) Select materials, finishes, and treatments on the basis of design requirements, not on existing aircraft practice or "the best there is" basis.

(6) Set work standards on as many operations as possible and *enforce them.* Also take advantage of some of the benefits of line-type layout modified to make it easy to remove a part from the line for special tests or "fixes."

(7) Don't draw all your key workers from the experimental shop. Although experienced with the job details, they bring with them the experimental pace.

(8) Use key production and material control people who are familiar with missile parts and understand the effects of engineering changes.

(9) Set up a rigid systems and parts designation for handling production parts. The control and scheduling of materials and parts are made more difficult due to the number of parts and frequent changes. Accurate designation and routing are essential because changed parts often look alike.

(10) From an organizational standpoint, a good approach is to form a small but strong group within manufacturing engineering that can analyze early designs and recommend changes. In such a case, an organization similar to that shown in the chart above should be used.

To Order Paper No. 44D . . .
. . . on which this article is based, turn to page 6.

GE 6118

GENERAL ELECTRIC

PRODUCTION ENGINE DEPARTMENT — **SPARE PARTS ITEM STATUS REPORT**

GE CONTROL NUMBER	CYCLE	MAVT	PRIORITY	CONTRACT	EXHIBIT	ITEM NUMBER	ITEM SUFFIX	DESTINATION	SCORE VERSION	STOCK CLASS	I. S.	FAMILY	MATL CLASS	SCHEDULED BALANCE QUANTITY	IN PROCESS QUANTITY	SHIPPED QUANTITY	PROCESS TAG NUMBER	UNIT COST	DATE OF PRINT OUT
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299D193	0	0	2	27	EX	0133	1	DC	58	0259	0002	0	1H	8					
299D193	0	0	2	27	EX	0133	1	DC	59	0259	0002	0	1H	8					
299D193	0	0	3	27	EX	0133	1	DC	60	0259	0002	0	1H	8					
299D193	0	0	4	27	EX	0133	1	DC	61	0259	0002	0	1H	8					
299D193	0	0	5	27	EX	0133	1	DC	62	0259	0002	0	1H	4					
299D193	0	0	5	27	MJ	0213	1	DC	65	0259	0002	0	1H	3					
299D193	0	0	5	27	MJ	0213	1	DC	66	0259	0002	0	1H	6					
299D193	0	0	5	27	MJ	0213	1	DC	67	0259	0002	0	1H	6					
299D193	0	0	5	27	MJ	0213	1	DC	68	0259	0002	0	1H	6					
299D193	0	0	5	27	MJ	0213	1	DC	69	0259	0002	0	1H	3					
299D193	0	0	6	21	A	0278		DC	46	0259	1060	0	1H						
299D193	0	0	6	27	MJ	0213	1	DC	65	0259	0002	0	1H			3			
														71	3	10*			

A B C D E F G H I J K L M N O P Q R

Fig. 1 — Printout section from a status tape. This tape contains all the information required to produce daily status reporting of all active items.

Computer Keeps an Eye on

GE uses a medium-size computer to process paperwork and to maintain perpetual status records for its entire spare parts activity.

Based on paper by

S. E. Parks

General Electric Co.

ELECTRONIC data-processing equipment and the production control of spare parts support for jet engines were made for each other!

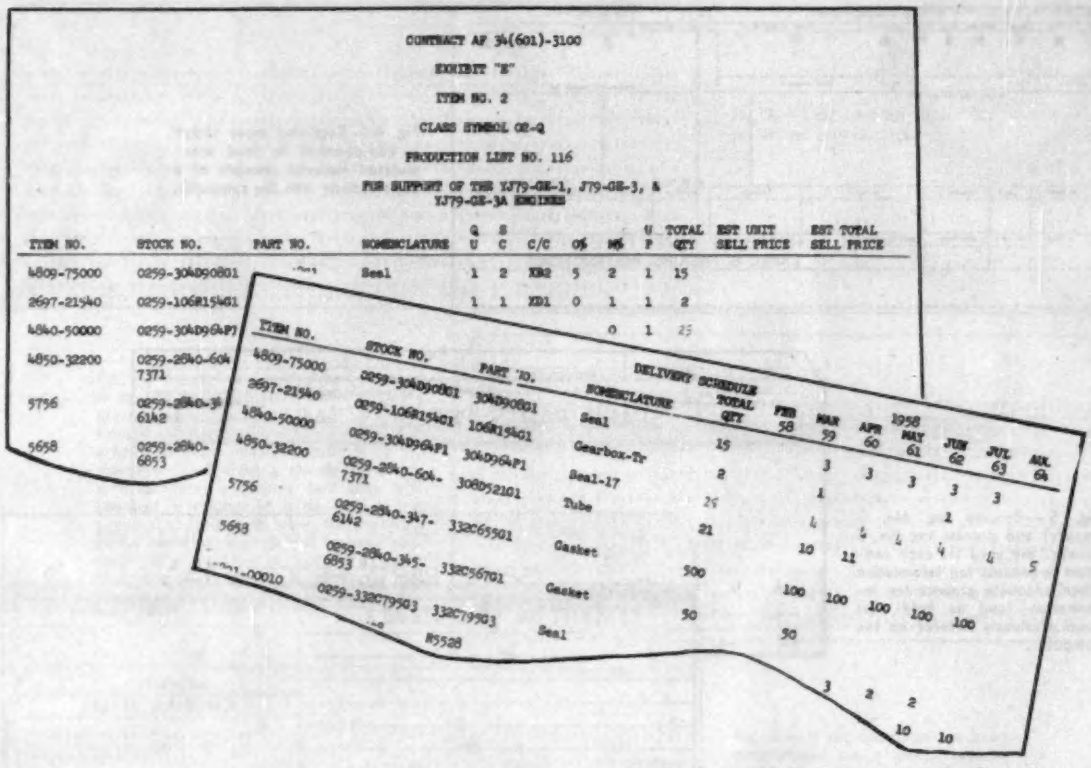
Using a medium-size computer, GE keeps track of over 30,000 different parts, going to 225 shipping destinations, and requiring identification to 1000 exhibits contained on 75 contracts. Also, the computer records the over-5000 engineering changes to parts designations, and accounts for the 50,000-or-so shop orders needed to ship parts requirements.

The brain of the computer is the magnetic drum or memory unit which can store 20,000 characters in 2000 individually addressable locations. Supplementing this are 4 magnetic-tape units and a special system which selects and prints from the tape record.

Information is fed into the computer by punched card. Holes in the card convert to significant electrical impulses for storage on the drum as a pattern of magnetized spots. Read-write heads are located to either magnetize the address or to read the data.

Programming is achieved by "loading" punched cards onto the magnetic drum, Transferring predetermined instructions to the unit in this way allows specific data to be automatically calculated by assigning "addresses."

The data for each calculation are transferred from the memory drum to an arithmetic unit. The results are then returned to the drum for temporary storage and for subsequent use in the same problem, or until the answer is ready for punched card or



CONTRACT AF 34(601)-3100

EXHIBIT "E"

ITEM NO. 2

CLASS SYMBOL GE-Q

PRODUCTION LIST NO. 116

FOR SUPPORT OF THE YJ79-GE-1, J79-GE-3, & YJ79-GE-3A ENGINES

ITEM NO.	STOCK NO.	PART NO.	NOMENCLATURE	Q U	S C	C/C	OS	MS	U P	TOTAL QTY	EST UNIT SELL PRICE	EST TOTAL SELL PRICE
4809-75000	0259-30AD90801		Seal	1	2	XB2	5	2	1	15		
2697-21540	0259-106R15461			1	1	XD1	0	1	1	2		
4840-50000	0259-30AD96AP1							0	1	25		
4850-32200	0259-2840-604-7371											
5756	0259-2840-3[illegible]-6142											
5658	0259-2840-6853											

ITEM NO.	STOCK NO.	PART NO.	NOMENCLATURE	DELIVERY SCHEDULE TOTAL QTY	FEB 58	MAR 59	APR 60	1958 MAY 61	JUN 62	JUL 63	AUG 64
4809-75000	0259-30AD90801	30AD90801	Seal	15		3	3	3	3	3	
2697-21540	0259-106R15461	106R15461	Gearbox-Tr	2		1			1		
4840-50000	0259-30AD96AP1	30AD96AP1	Seal-17	25		4	4	4	4	4	5
4850-32200	0259-2840-604-7371	308052101	Tube	21		10	11				
5756	0259-2840-347-6142	332C65501	Gasket	500		100	100	100	100	100	
5658	0259-2840-345-6853	332C56701	Gasket	50		30					
[illegible]-00010	0259-332C79503	332C79503	Seal			3	2	2			
		R5528						10	10		

Fig. 2 — Typical production list. This list carries the items of information to be translated into machine language.

Spare Parts

printed report. The memory drum can be scanned for selective reading at the rate of 25,000 characters per sec!

A console panel is available for observing or rejecting data and instructions, thus allowing complete command of the unit.

The tape units supplement the capacity of the memory drum. Using electric impulses to spot magnetic impressions on the tape surface, up to 50,000 records of 100 digits each can be put on a 10½ in. diameter reel.

These tape units work in conjunction with the master unit, and may be searched intermittently by that unit. The tapes may be used repeatedly because the unit automatically erases previous data as new data is included. Simultaneous operations of reading and writing permit full utilization.

The tape data selector frees the main frame for calculation purposes while it prints reports. It scans and selects specific data from a tape and prints it at a rate of 150 lines per min. It can also be used as a conventional tabulator, accepting 150 cards per min for input.

This, then, is the physical description of the computer arrangement used to process paperwork and

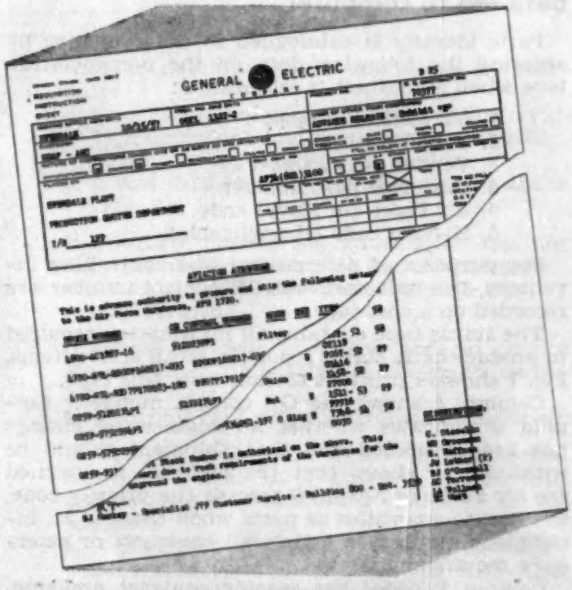


Fig. 3. — Typical instruction sheet. This document, a record of shipping authority, not only indicates original order receipt, but it also is used to announce any changes in an order.

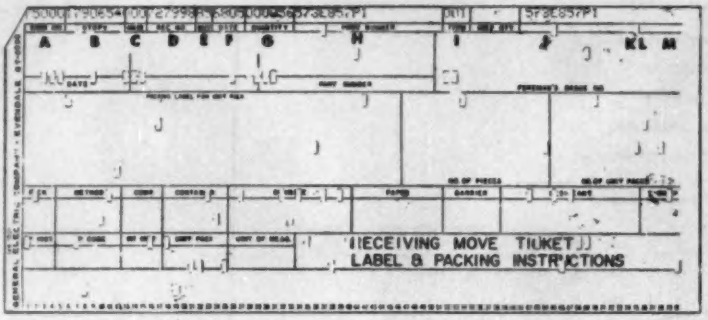


Fig. 4 — Receiving move ticket is key-punched to feed accumulated material receipts of a day's activity into the computer.

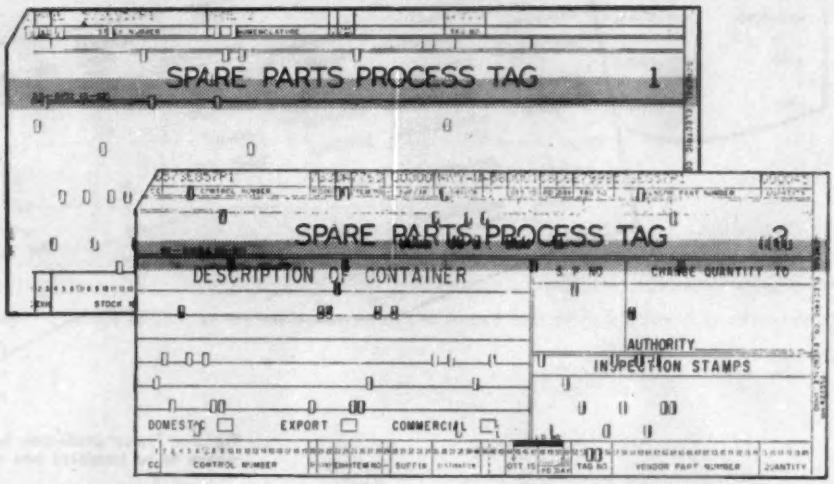


Fig. 5 — Process tag No. 1 (upper) and process tag No. 2 (lower) are used for each variation in process tag information when adequate process tag information (and no hold) has been previously entered on the computer.

to maintain perpetual status records for the entire spare parts activity.

data fed to computer

Parts identity is catalogued in the computer by entering the following data on the nomenclature tape when a contract is established:

1. GE control number
2. Nomenclature
3. Vendor part number
4. Customer part number
5. Air Force (or Navy) code
6. Hi-valu code (if applicable)

For purposes of determining and controlling inventory, the unit cost and GE control number are recorded on a cost tape.

The status tape contains all information required to produce daily status reporting of all active items. Fig. 1 shows a printout section from this tape.

Column *A* shows the GE control number. Column *B* indicates whether an engineering change has been proposed and that shipment should be withheld. *C* shows that the material is destined for Air Force or Navy. *D* records the priority code, to allocate quantities of parts when there is an insufficient number to satisfy all contracts or emergency requirements.

Column *E* codes the specific contract applying, since the same part likely appears on several contracts. Column *F* indexes the part to sections of the contract, designated exhibits. *G* further identifies the part by specifying the sequence number of the exhibit item. *H* contains the destination code for shipment. *J* is the stock class by which the services identify various types of material for warehousing purposes.

Column *K* specifies the instruction sheet which authorizes material shipment. *L* is not currently used, but will later provide inventory class of material for inventory control purposes. *M* refers to the type of packing requirements for factory load planning. *N* refers to the scheduled balance quantity. *O* indicates received material being prepared for shipment.

Column *P* is the shipped quantity. (The computer maintains strict quantity accounting in this report.) *Q* identifies the work order which authorizes, allocates, and directs each shipment. *R* shows the unit cost of the item.

The computer provides daily advice on the status of all items.

Addition to, or correction of, contract specifications is coded into the status tape upon receipt of a production list (Fig. 2) from marketing. The production list indicates the items of information to be translated into machine language.

An instruction sheet (Fig. 3) may accompany the production list. This document, a record of shipping authority, not only indicates original order receipt, but also announces any changes in an order.

Factory activity on items is reported on a daily basis. This is done by automatic equipment located

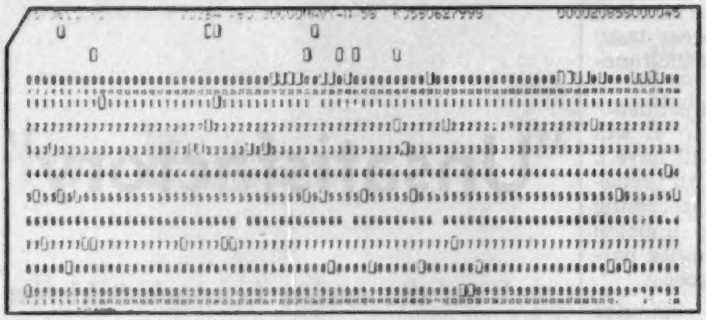


Fig. 6 — Cost card for each set of two process tags.

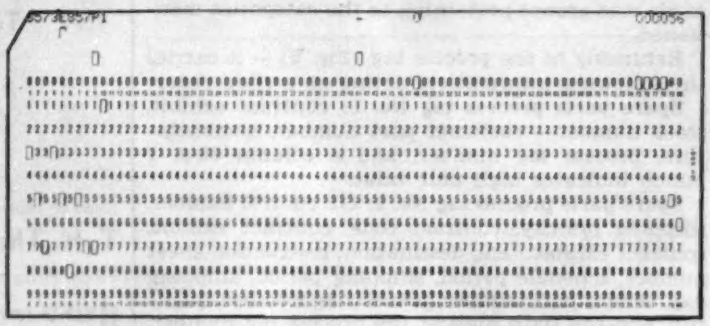


Fig. 7 — Surplus card with a zero punched in column 48 is generated when adequate process tag information has not been previously entered on the 650 computer. If a hold has been previously entered on the computer (indicating a change in design is in process) a surplus card with a *1* punched in column 48 is issued. A *2* is punched in column 48 when the receiving move ticket or the special request pertains to a quantity of material greater than the "scheduled quantity" on the computer.

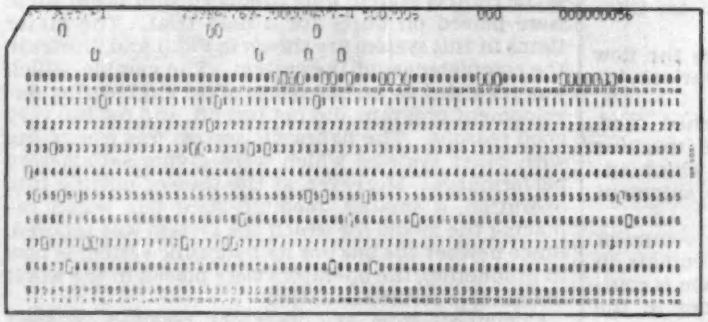


Fig. 8 — If the computer has been programmed (by a special request card) to perform some function other than the preparation of process tags; and, if the computer cannot perform the function, an "unmatched shipment and adjustment" card with no *x* in column 41 will be generated. (All other cards will have *x* in column 41).

at control points, which translate that activity into report terms.

Fig. 4, the receiving move ticket shows how accumulated material receipts of a day's activity are key-punched to feed that data into the computer.

The receiving office prepares this form simultaneously with preparation of the receiving report. *a* is the vendor code and identifies the supplying vendor. *b* indicates the purchase order. *c* is the purchase order amendment. *d* is the receiving report number. *e* identifies the purchasing buyer. *f* records the date that the material was received. *g* is the quantity of material received. *h* is the vendor's part number. *i* is the sequential listing of the item on the purchase order. *j* is the GE control number. *k* indicates whether material receipt satisfies material certification requirement or vendor government inspection surveillance. *l* identifies the location of the material in receiving. *m* is shown when the material is comprised of rubber and the curing data appear on the packing slip.

Data processing then uses the receiving move ticket and special request cards to obtain the following from the computer:

1. If adequate process tag information (and no hold) has been previously entered on the computer,
   a. Two cards, representing process tags (Fig. 5) number one and two, for each variation in process tag information, and
   b. A cost card for each set of two cards above (Fig. 6).
2. If adequate process tag information has not been previously entered on the 650 computer:
   a. A surplus card with *0* in column 48 (Fig. 7) is generated.
3. If a hold has been previously entered on the 650 computer (indicating a change in design is in process):
   a. A surplus card with *1* in column 48 is issued.
4. If the receiving move ticket or the special request pertains to a quantity of material greater than the "scheduled quantity" on the computer:
   a. A surplus card with *2* in column 48 will be generated (process tags will be issued for the "scheduled quantity" only).
5. If the computer has been programmed (by a

special request card) to perform some function other than the preparation of process tags; and, if the computer cannot perform the function:

a. An "unmatched shipment and adjustment" card (Fig. 8) with no *x* in column 41 will be generated. (All other cards will have *x* in column 41). Simultaneously with preparation of a process tag, data processing changes the computer record to indicate that all or a portion of the "scheduled balance" has now been placed "in process."

Data processing then sorts the above computer cards into groups pertaining to the categories mentioned.

Returning to the process tag (Fig. 5) — it carries the following information, acting as a shop order:

Spare parts process tag No. 1: contract exhibit, stock number — customer part number, nomenclature, process tag number, and a column 80-A *1* punch indicates high unit value.

Spare parts process tag No. 2: GE control number, shipping priority, contract code, contract exhibit, contract exhibit item, destination, instruction sheet number, schedule period, shipping period, shipping day, vendor part number, process tag number, quantity, and the sixth digit of the process tag number.

The process tag is relayed to material for integrated processing through the factory.

Other data processing equipment traces the flow of family groups of material through various inventory control points.

When shipment is made, a key punched card, produced automatically by a cardatype machine (Fig. 5, tag No. 2), advises the computer which adjusts data to current status and records shipment on a history tape.

Previously being programmed into the computer is a routine by which spare parts requirements in terms of quantity and schedule for each item is computed for optimum support of jet engines in the field. Engineering data relative to the part's operating life, current military flight programming, quantity supplied and on order, will determine contract requirements.

In addition to acting as a necessary tool for customer service and factory system support, the computer provides the following luxury benefits:

1. Reduction of indirect manufacturing expense. Computer abilities have greatly reduced the requirements for production control clerks.
2. Flexibility. Programming changes can be accomplished in relatively short time.
3. Load level adjustability. The computer is immediately able to gear itself to various production levels.
4. Capacity for varied functions. If applications can be reduced to mathematical terms, it will perform the drudgery of repeated operations. Payroll records, checks, pay changes, overtime calculations, and such for 6000 employees are currently being administered by the computer.
5. Special reports. Statistics may be rapidly assimilated into desired analysis form for management review and decision making.

To Order Paper No. 45C . . .
. . . on which this article is based, turn to page 6.

"Unsatisfactory"

. . . is the answer from one field test

Test on 50 buses—by NY Transit

Based on paper by

T. H. Thomas

Bendix Products Division, Bendix Aviation Corp.

USING low production tooling, 500 sets of a hydraulic control system were produced, and 433 of these were placed on buses for a field trial. The major items in this system are shown in Fig. 1 and illustrate the completeness of the system. The gamble, which was regarded as an extension of an engineering development program, did not pay off, and for two very good reasons. The hydraulic system was competing with other systems which were giving satisfactory performance. Moreover, at the time of putting into operation, a smaller, medium-sized bus began replacing the model for which the system was tailored. Since neither the bus nor its hydraulic system is now in production, the operators were placed in the worst imaginable service situation.

Comments from two operators, received on April 18, 1958, indicate the following:

1. Modifications were costly to the operator, leading to the choice of conventional systems on later buses.
2. Trouble with bladders in production industrial-type accumulators is still serious.
3. The hydraulic brake system and power steering work well.
4. Absence of other comments suggest other components working satisfactorily.
5. Eight buses were placed in storage in March, 1958, due apparently to the trouble of servicing in an otherwise standardized fleet.

Why the Experiment Didn't Pay Off

This experience suggests high initial and maintenance costs to have been the most serious disadvantage. At the same time it is believed actual production on a large scale would eliminate these obstacles. There still remains the question, how can a complete hydraulic system win a foothold and compete with other systems now firmly intrenched through long development and use?

To Order Paper No. 52A . . .
. . . on which this article is based, turn to page 6.

for Buses . . .

of a complete hydraulic control system. Authority—ran for two years.

IN the years 1950 and 1951, a complete hydraulic control system was placed in service on 433 Mack C-50 buses, operated for the most part by the New York Transit Authority. The purpose of such a field test was to determine if such a system actually did have the advantages thought to be inherent in it.

Here is told why the system proved unsatisfactory, what troubles showed up, and the obstacles to be overcome before a hydraulic system can supplant either the electrical or pneumatic system.

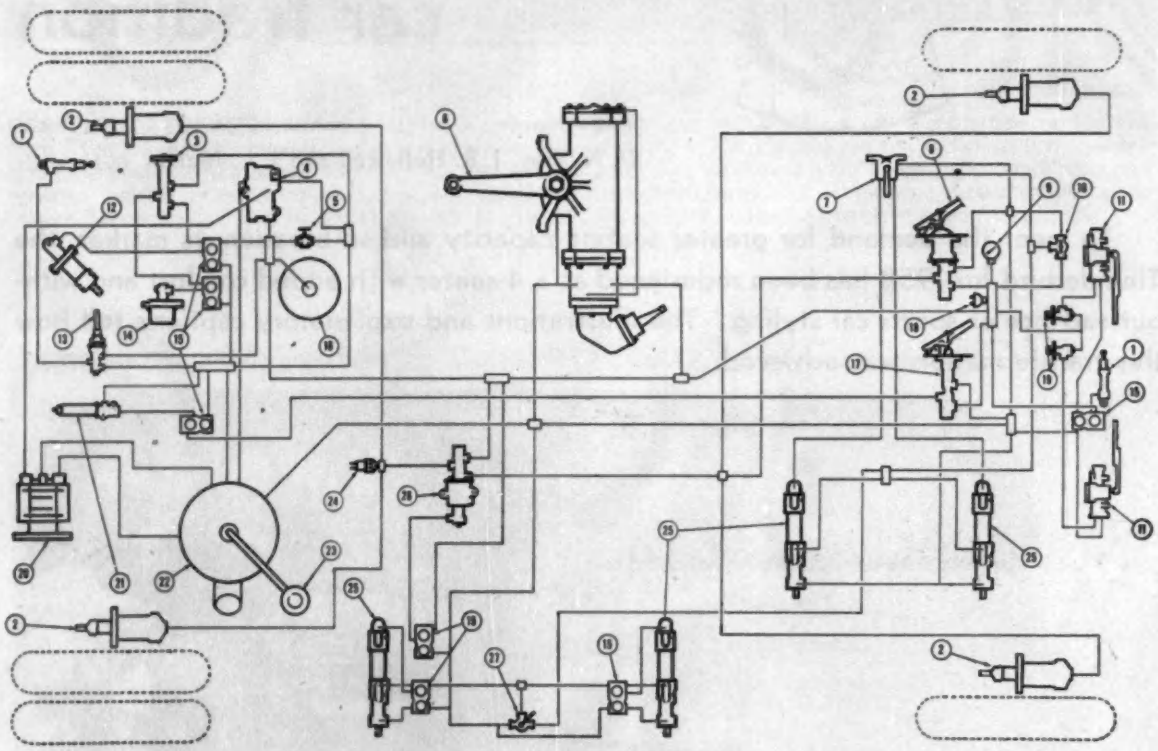
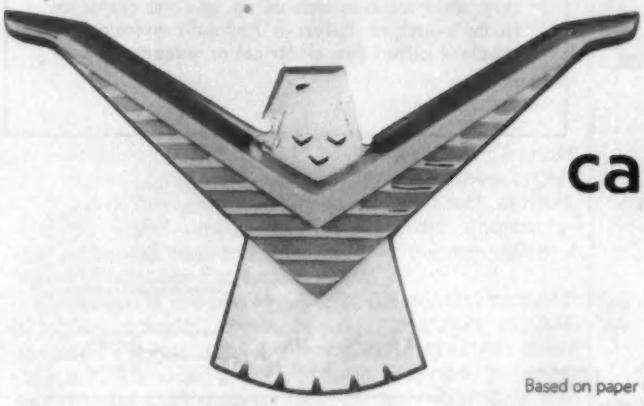


Fig. 1 — Diagram of the complete hydraulic control system field-tested on 433 Mack C-50 buses. The major items are keyed as follows:

1. Shutter and damper cylinder
2. Brake cylinder
3. Pressure reducer
4. Pressure regulator
5. Crane valve
6. Hydraulic steering gear
7. Door control valve
8. Brake control valve
9. Pressure gage
10. Door system dump valve
11. Windshield wiper engine
12. Clutch cylinder
13. Shutter control valve
14. Shift cylinder
15. Various three-way solenoid valves
16. Accumulator
17. Throttle valve
18. Low-pressure warning switch
19. Windshield wiper control valve
20. Gear-type hydraulic pump
21. Throttle slave cylinder
22. Oil reservoir
23. Reservoir air cleaner
24. Stoplight switch
25. Door actuating cylinder
26. Brake interlock valve
27. Emergency dump valve

Thunderbird for 1958

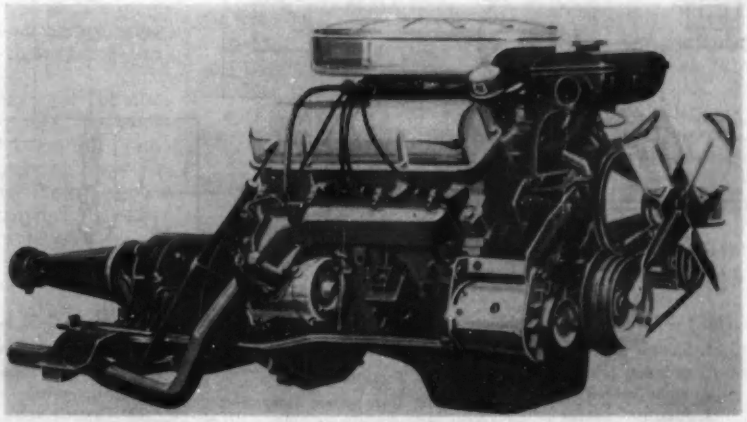


. . . a family car in the sports car tradition

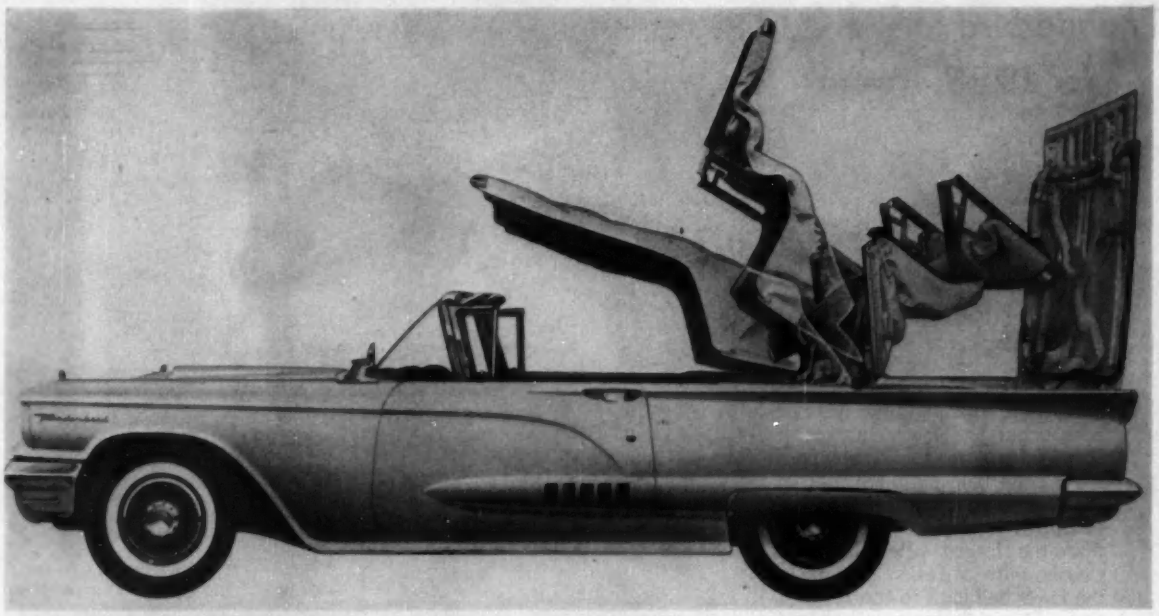
Based on paper by

D. N. Frey, J. R. Hollowell and J. L. Martin, Ford Motor Co.

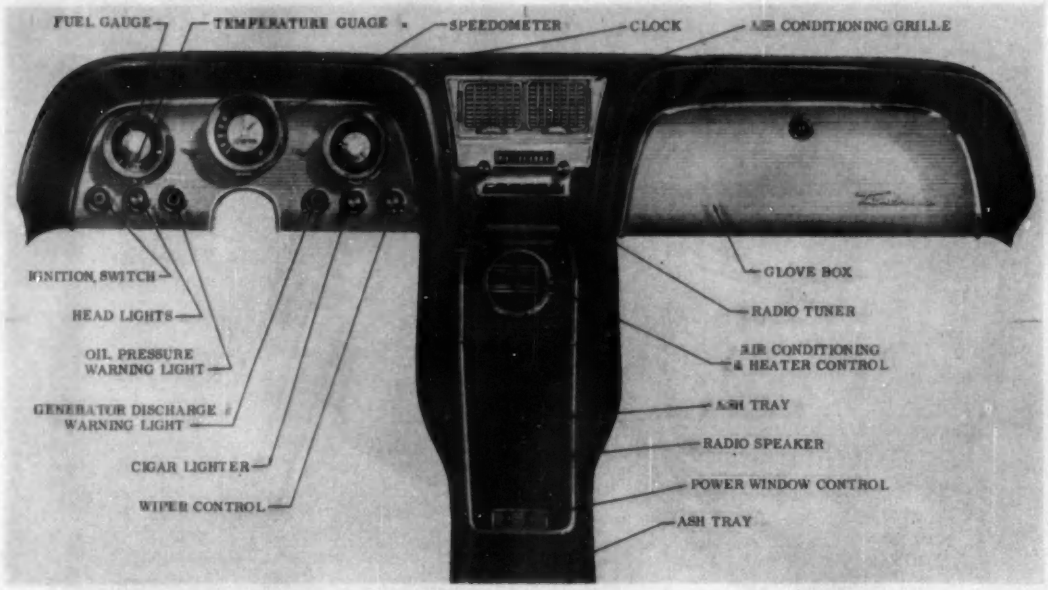
To meet the demand for greater seating capacity and so broaden its market, the Thunderbird for 1958 has been redesigned as a 4-seater with added comfort and without sacrifice of sports car styling. The illustrations and explanatory captions tell how this transformation was achieved.



ENGINE IS ONE OF A NEW SERIES — a 90-deg OHV-8 of 352 cu in. Equipped with a 4-barrel carburetor, it develops 395 lb-ft of torque at 2800 rpm and 300 hp at 4600 rpm with 10.2/1 compression ratio. Combustion chamber is wedge-shaped, and machined throughout to give precision in volume and to reduce combustion deposits. Large 18-mm, turbo-action spark plugs with increased electrode penetration of combustion chamber improve flame propagation. Engine breathing has been improved by increasing valve port diameters to 1.80 in. for the inlet and 1.32 in. for the exhaust. Weights of engine front cover and crankshaft damper have been reduced by substituting steel stampings for castings. Addition of hydraulic valve lifters makes for quieter operation and reduced maintenance.



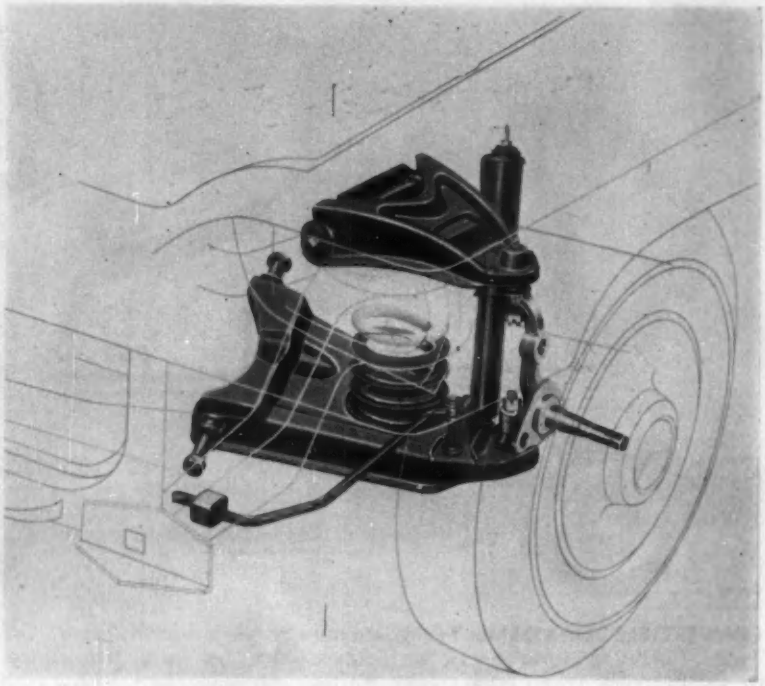
CONVERTIBLE TOP ASSEMBLY folds into trunk compartment. Top linkage is operated by two hydraulic pistons fed by an electrically driven pump. Deck lid has electrically operated solenoid locks controlled by key lock switch in driver's compartment. It is hinged at the rear and has a safety catch. Only sections of the convertible not identical with the hardtop model are the rocker section, quarter-panel area, windshield upper moldings, top stack and upper back finish panel, deck lid hinges and counterbalance (although deck lid itself is the same as on the hardtop).



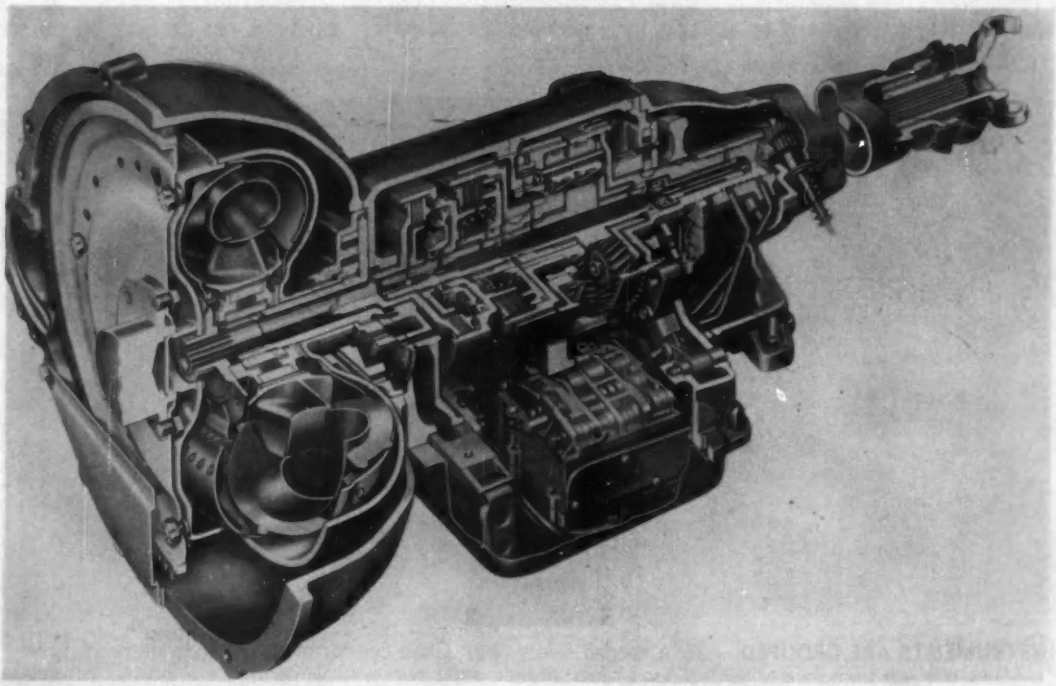
INSTRUMENTS ARE GROUPED under a hooded safety pad. Glove compartment has separate hooded pad. Front and rear ash trays, heater control head, radio speaker, and power window controls are located in tunnel console. Rear ash tray and central power window controls are easily reached by rear occupants through gap between bucket seats.

continued

Thunderbird for 1958 ... continued

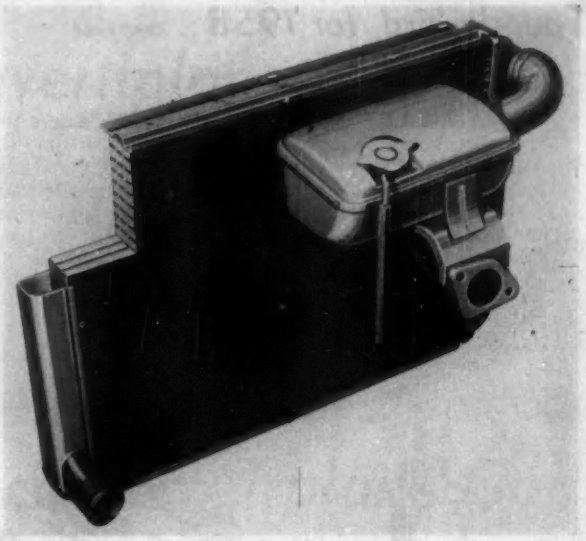


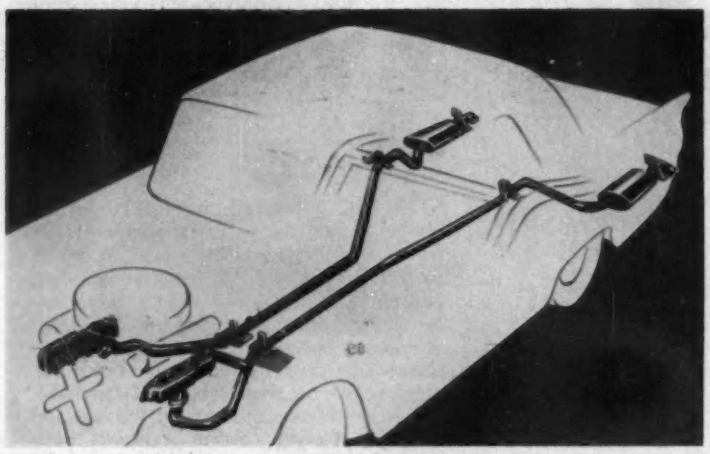
FRONT SUSPENSION SYSTEM employs one-piece stamped steel construction for upper and lower control arms. Lower arms are sweptback. Inclining the front of both upper and lower suspension arms softens road bumps. Ford angle poise ball joints are used in modified form. Ball sockets are a simplified stamped steel rather than the forged type used previously, with a Teflon bearing in the lower ball joint to control friction. This gives better directional stability and less road wheel disturbance.



CRUISE-O-MATIC TRANSMISSION allows first gear start at driver's option. A low final ratio of 3.10/1 reduces engine speed throughout driving range to give quietness, smooth operation, and fuel economy. Second-gear starting to allow light torque applications during winter driving is available through manual selector positioning, while a low range is still provided for maximum pulling or engine braking.

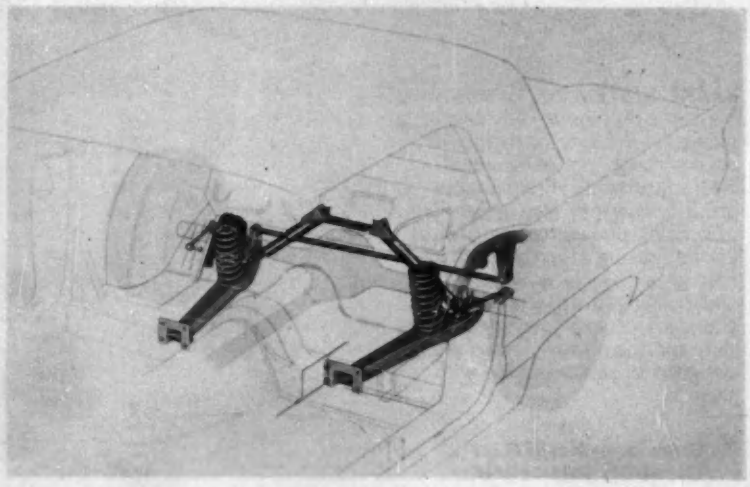
COOLING SYSTEM DESIGN accommodates large engine and low hood line. In lieu of upper and lower radiator headers, a crossflow system is used with headers of one-half conventional capacity placed at sides of the core. An expansion tank, bolted to the engine block, replaces the upper header and adds to coolant capacity.





DUAL EXHAUST PIPES of 2-in. diameter are routed through the driveline tunnel, up over the rear axle, to mufflers of 552 cu in. capacity in the rear quarter panels. Mufflers are double-wrapped, zinc-coated steel with an asbestos layer for best acoustics and long life. A crossover pipe interconnecting the two muffler inlet pipes below and rearward of the engine increases the effective volume of the system and improves the tuning so that resonators are unnecessary. The several features add up to good clearance, concealment, and heat dissipation for driver and passenger comfort.

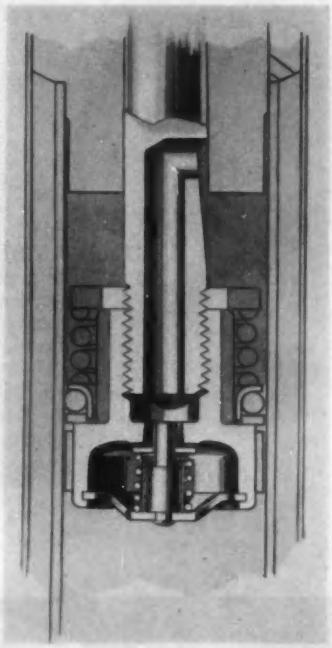
TRAILING REAR ARM SUSPENSION comprises trailing arms, track bar, and upper torque reacting member. Arms are splayed to provide roll control while maintaining the desired spring center distance and to obtain maximum track bar length for proper handling. They are attached to the underside of the axle by pivots. An extension of the trailing arm engages a bracket, fixed to the axle, through rubber pucks. Use of a common stamping for both arms simplifies tooling. The track bar is welded to the right-hand arm. Rear coil springs of 185 lb per in. rate and 1300 lb load operate on a 1.3/1 lever ratio and provide ride rates with tires of 140 lb per in. The roll rate is 171 ft-lb per deg and natural frequency at curb load is 82 cycles per min.

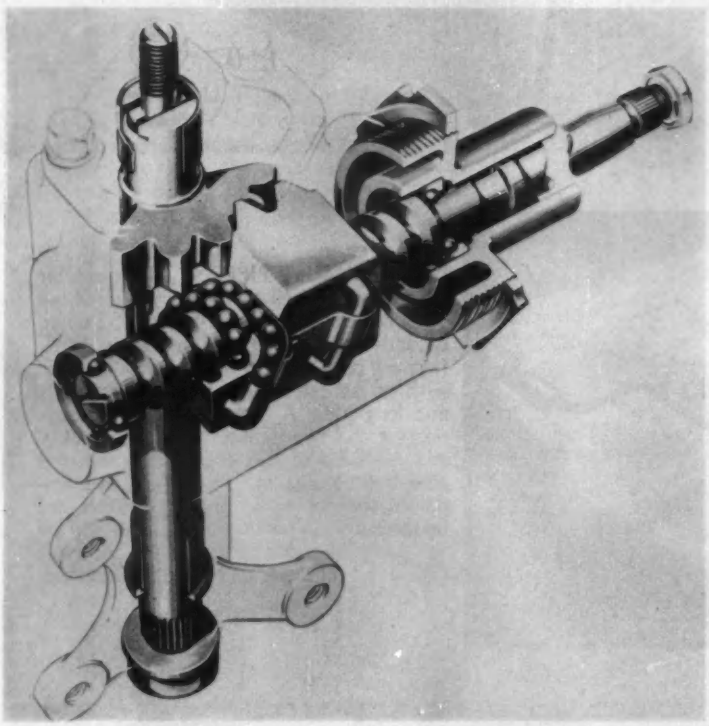


continued

Thunderbird for 1958 ... continued

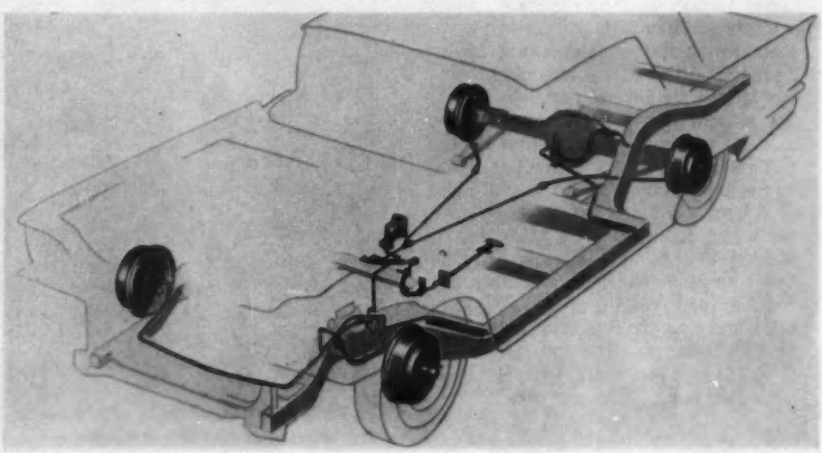
HYDRAULIC CUT-OFF SHOCK ABSORBERS feature the front suspension. As the wheel goes into rebound, the shock absorber fluid flowing through a graduated port is gradually restricted by a close-fitting rod guide. The rate of resistance increases until the port is closed, creating a hydraulic lock which prevents further movement. Rubber rebound bumpers are eliminated and the severity of the "strike-through" is reduced to give a better ride balance and cornering stability. The shock absorber is now positioned outside the coil spring, where it requires about half the resistance needed previously.





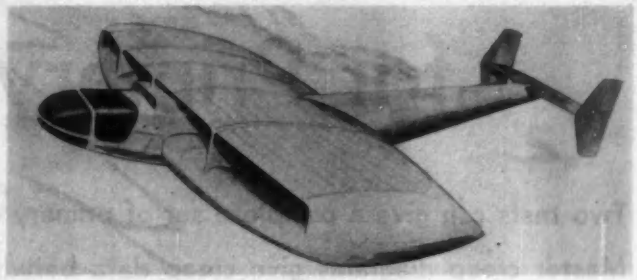
STEERING LINKAGE has parallelogram design. Spindle arms are forged integrally with spindles for rigidity and economy of parts. Steering gear is of the recirculating ball-nut type for high efficiency, better retention of preload, and long life. Reduced tolerances between unitized body and chassis components eliminate need for steering gear housing-to-body sill shimming, which simplifies operations on the line and banishes steering column squeaks... Both manual and power steering systems have a 25/1 overall steering ratio and a 40.3-ft curb-to-curb turning diameter.

BRAKE SYSTEM employs double-seal, duo-servo, self-energizing, 11-in. brakes with a fixed anchor design providing simplified adjustment. Front brakes are 2½ in. wide; rear brakes 2 in. Front brakes receive 62% of the braking effort while the rear get 38%. The wide secondary linings are specially compounded for high performance duty and the primary linings are designed to be compatible with them.

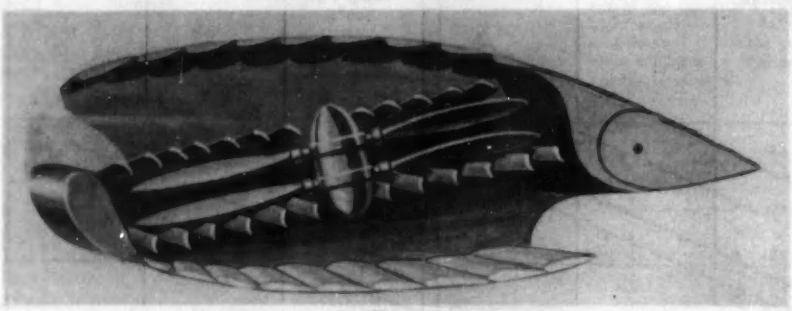


To Order Paper No. 59A ...
... on which this article is based, turn to page 5.

Shrouded Rotor Convertiplane Design Bridges Helicopter-Airplane Gap

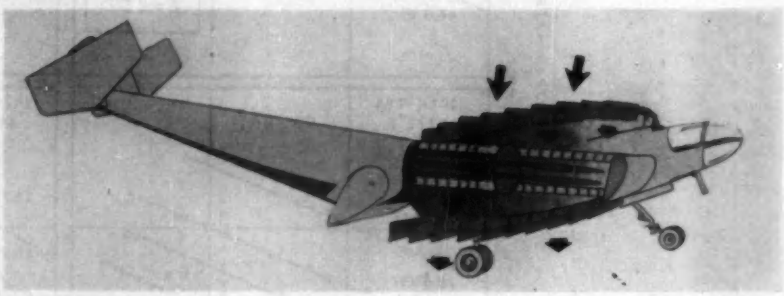


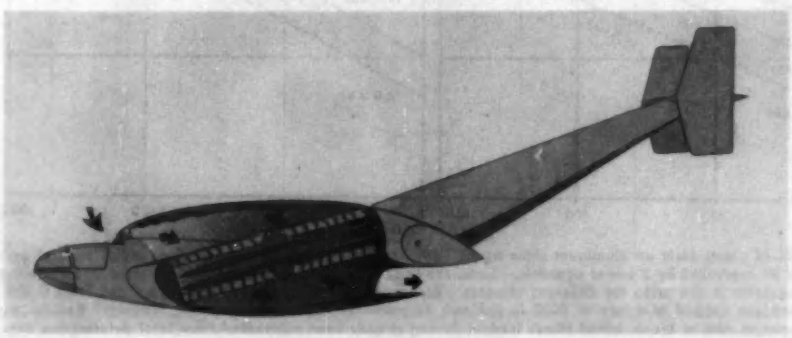
Based on paper by **R. S. Ross and R. S. Johnson, Jr.,** Goodyear Aircraft Corp.



HOVERING EFFICIENCIES close to those of a helicopter were found by Goodyear in its buried rotor studies and tests. By ducting the air rearward, greater than helicopter forward flight speeds are obtained.

DURING TAKE-OFF OR LANDING operations, vanes at the bottom and top of the wing let air pass straight down through the rotor.





IN FORWARD FLIGHT the outside vanes are closed but the inside vanes and shrouding still force the air flow straight through the rotor. This overcomes the need for cyclic pitch control used on helicopter rotors.

To Order Paper No. 37A . . . . . on which this article is based, turn to page 5.

How to Simplify Tests for Primary Creep Data

Two tests can give a complete set of primary creep curves for one temperature . . . Master creep diagrams give creep data between test temperatures.

Based on paper by **B. B. Muvdi,** Martin Co., and **C. J. Giemza,** Convair-Astronautics

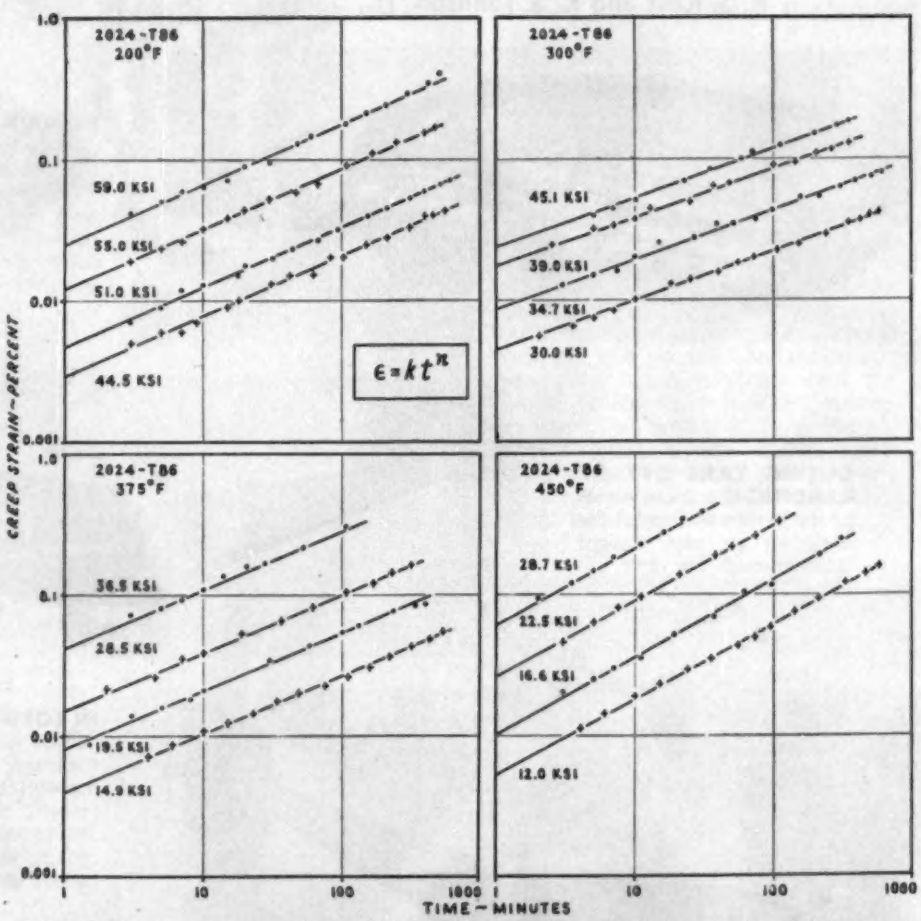


Fig. 1 — Results of creep tests on aluminum show up as straight lines on log-log paper. This indicates that primary creep can be expressed by a power equation. Since the lines are parallel for any one temperature, the exponent in the power equation is the same for different stresses. Standard pin-load-type specimens were cut from 0.100-in. sheets. Load was applied at a rate of 6000 lb per min to minimize creep action during loading. Results are only the deformation due to creep, initial stress loading having already been subtracted from total deformation data.

LOW limits on allowable deformation of aircraft and missile structures may make the creep behavior of a metal the critical factor in the choice of metals to be used. Present estimates put the allowable deformation at 0.5% maximum for both creep and plastic flow due to overstressing. This means creep properties of metals must be examined in the little known range of primary creep.

The primary creep range is characterized by a high rate of change of deformation for a short time. To date the most work has been done on secondary creep which exhibits a near constant rate of creep and large deformations.

Experiments on aluminum, stainless steel, and titanium show that only two tests are needed to predict primary creep at a given temperature. This is because the creep-time curve follows an exponential equation and the constants of the equation have a relatively simple relationship with stress level and temperature.

Creep is defined by:

$$\epsilon = kt^n$$

where:

ϵ = creep deformation,%
t = time, min

n and k are constants for a given material, stress level, and temperature

When actual tests were run on sheets of aluminum, the results were straight lines on log-log paper. This verified the equation and further indicated that n was independent of stress level. Fig. 1 shows the results for four stress levels and temperatures. Subsequent plotting turned up the fact that k varied in a logarithmic fashion with stress level. At any

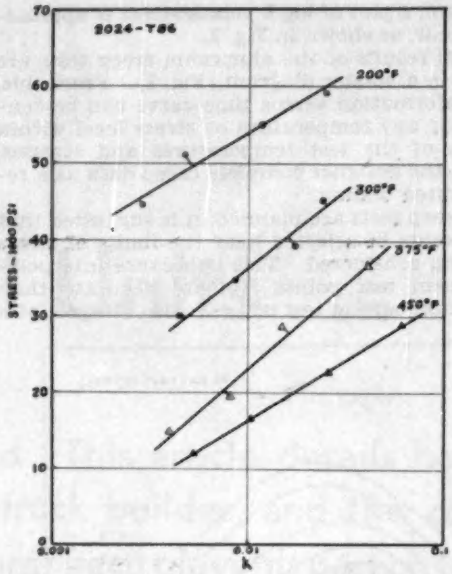


Fig. 2 — Need for extensive testing is reduced because one of the consonants (k) of the creep equation varies logarithmically with the stress. Two test runs can be used to find k for any temperature. From Fig. 1 the other constant (n) can be found from one test run at a given temperature.

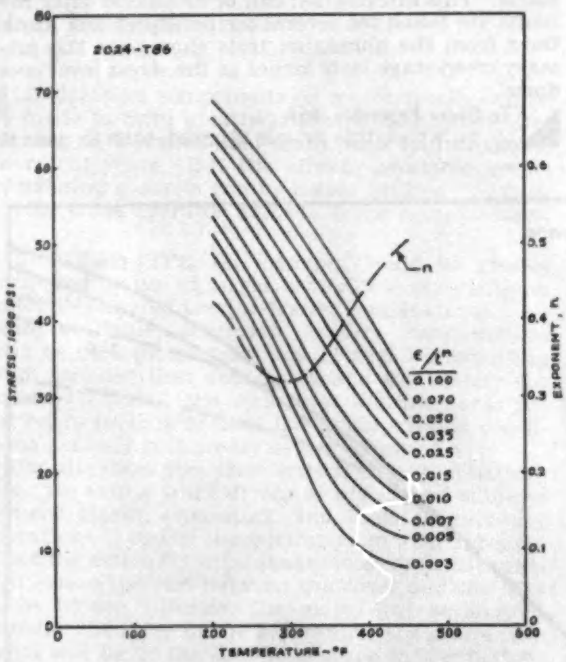


Fig. 3 — Complete information on primary creep of 2024-T86 aluminum can be found from this master creep diagram. It was constructed from Figs. 1 and 2. The creep equation, $\epsilon = kt^n$, can be written for any temperature and stress level. $k(\epsilon/t^n)$ is found for the stress and temperature and n for the temperature in question.

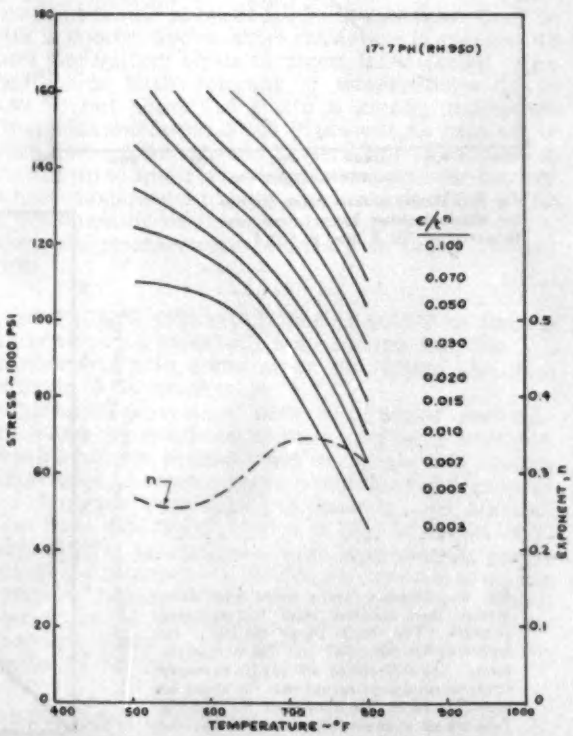


Fig. 4 — A master primary creep diagram for 17-7PH stainless steel was constructed in the same manner as the one for aluminum.

temperature, a plot of log k versus stress is approximately linear, as shown in Fig. 2.

The final results of the aluminum creep tests are combined in a master diagram (Fig. 3). From this, a creep deformation versus time curve can be constructed for any temperature or stress level within the limits of the test temperatures and stresses. This gives the designer complete creep data as a result of limited testing.

When creep tests are planned, it is suggested that the test points be selected near the limits of stress range being considered. This is because interpolation between test points is more accurate than extrapolation beyond test points. Also, the plot of n versus temperature in Fig. 3 is erratic enough to make extrapolation unreliable.

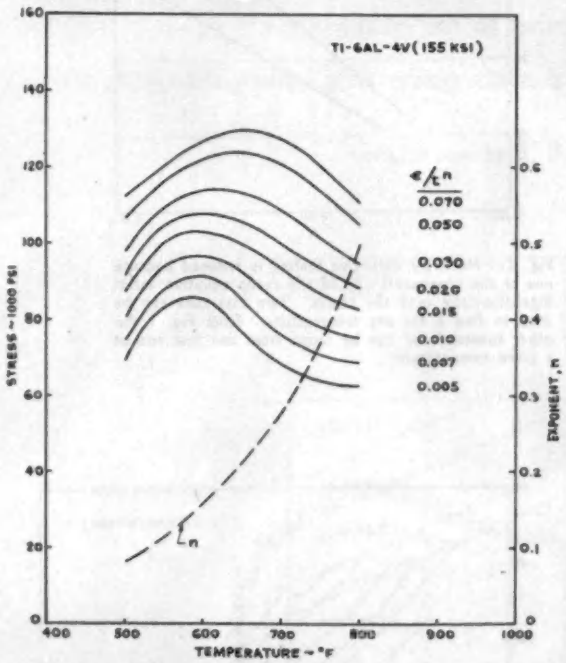


Fig. 5 — Master primary creep diagram for titanium shows better creep performance at 700 F than at 500 F.

Creep Performance of Steel and Titanium

Tests run on stainless steel and titanium rated titanium higher on deformation performance. The materials used were:

17-7 PH stainless steel
6A1-4V titanium (heat-treated to 155 ksi)

Master creep diagrams for steel and titanium are given in Figs. 4 and 5. From these curves Fig. 6 was constructed to show which material was better. In Fig. 6, the total deformation is plotted against stress density for deformation due to load only ($t = 0$), and deformation due to load and creep ($t = 10$). Using stress density automatically takes into account the difference in strength-weight ratio of the two materials.

The three series of tests were performed with a constant load during each test run. This is a simplification of the random-type loading that is encountered in missiles and aircraft. U. S. Steel Corp. has reported changing creep characteristics with the method of loading for a steel containing 2.25% Cr and 1% Mo. Battelle Memorial Institute indicates differences in creep for a material loaded in tension and compression. Changing creep performance with different heat-treatments has also been reported by other experimenters. These factors should be investigated for aircraft materials before the constant-load master creep diagrams are completely accepted.

The master creep diagrams do not predict when the primary creep stage is over and secondary creep starts. This information can be estimated after the limits are found for several temperatures and loads. Data from the aluminum tests show that the primary creep stage lasts longer as the stress level goes down.

To Order Paper No. 46A . . .
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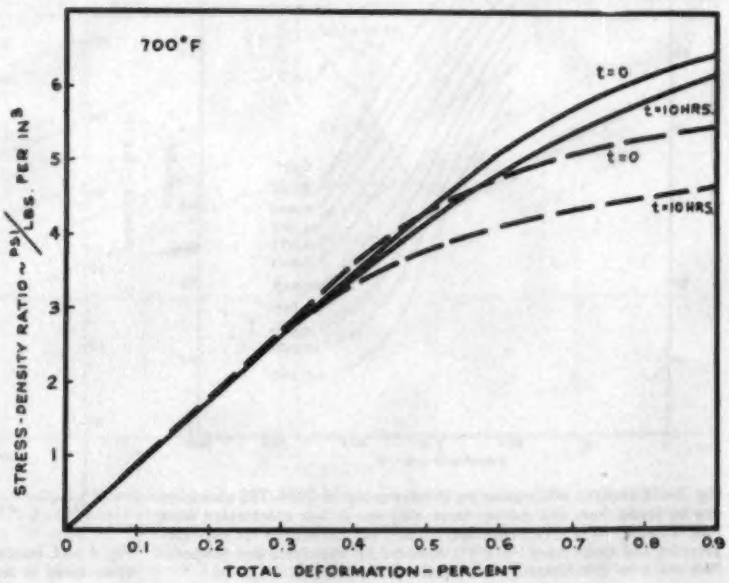


Fig. 6 — Titanium has a lower total deformation than stainless steel for equivalent strength. The results shown for 700 F also hold true for 500, 600, and 800 F temperatures. The t-O curves are similar to regular stress-strain curves except that the stress has been divided by the density of the material. This allows a direct comparison of the two materials.

Longer Life for Truck Electrical Units . . .

. . . can be had. This article details how the operator, the truck builder, and the component manufacturer each plays his part on batteries, generators, regulators, starting motors and distributors.

Based on paper by
H. L. Hartzell,
Delco-Remy Division, General Motors Corp.

ALL electrical components on motor trucks can be made to have greatly improved durability. Designers have contributed many such improvements in recent years. But the already-available merits of existing controls can be better utilized . . . both by the truck operator and the truck manufacturer.

BATTERY LIFE, for example, could be greatly increased by use of larger batteries — especially on gasoline-powered tractor-trailer combinations. Already-available, improved battery constructions may be used successfully, too, provided a mounting were supplied that does not shake the battery too much. (Luckily, the structural improvements injected to prolong battery life under cycling conditions actually help under severe vibration.)

But vibration does have serious effects on battery life. An empty truck driven at high speed subjects battery plates, separators, and seals to excessive vibration . . . causes the separators to wear through. Then the active material shakes loose from the grids and causes the seal between the cover and the case to be broken. Result: the plates will be shorted through the holes in the separators; the active material will be in the sediment space in the bottom of the case; and the sulfuric acid will spew over everything. Locating the battery where temperatures are neither too hot nor too cold will also increase battery life. A battery seems to enjoy an ambient temperature of 110 F. Below that, its cycle life is poorer; above, chemical action is speeded up and the battery tends to digest itself faster. The battery is fairly tolerant of temperatures up to 130 F; but above 150 F life is greatly shortened. Temperatures around 200 F present an impossible situation as far as good battery life is concerned. . . . It's up to the truck designer to locate the battery where moderate ambient temperatures exist. The truck operator, on the other hand, is responsible for the good maintenance necessary to better battery life.

ADEQUATE GENERATOR CAPACITY to handle all continuous loads will help battery life, too . . . particularly with a charge at idle, where idle time is likely to be appreciable.

Optional generators, with both better performance and better durability have long been available. But it's hard to equip a truck salesman with enough knowledge to recommend exactly the right generator for each particular application. All tractors that have continuous electrical load in excess of 50 amp should be equipped with high-output, early-cut-in a-c generators and with the recently available compact, rugged, lower-loss silicon rectifier (small enough to be assembled as part of the generator package). The a-c regulator can give better performance for its size than the d-c unit.

STARTING MOTORS, as used in trucks, are worked near to their peak rating. So, exhaust manifolds reach high temperatures. Temperature

Longer Life for Truck Electrical Units

. . . continued

shields to insulate the starting motor from the exhaust are helping to reduce the high temperatures resulting from some designs in which the exhaust system is wrapped around the starting motor. Temperatures can get high enough, however, to drive the lubrication from the bearings, cook the electrical insulation, and dry the lubrication from the motor drive.

A feasible reduction from 20 to four of the different types of starting motor would be a desirable simplification. Many of the 20 drives now in use have the same load ratings. Each is supplied with from two to seven different pinion designs. . . . But four drives would handle all the engines now being used in highway trucks. Each of the four could have a different load rating — with not more than two different pinions for each.

Regulator settings tailored to a particular truck operation will also help toward better battery life. The regulator, a service unit for the battery, often should be adjusted with the change of seasons. Different types of operation often require different settings. Also, the correct voltage may be different for each truck. So, neither the regulator nor the truck manufacturer can preset the voltage regulating unit for best battery life. Besides, the vibrating-contact regulator — to be reliable — must have its contacts enclosed in a tight package . . . a package provided with adequate gaskets, resulting in a good seal when the covers are tightened down. With a tight package, the voltage unit contacts will have a surprisingly long life.

Ignition distributors have been much improved in recent years. But, to insure satisfactory performance, they require:

- Periodic changing of contacts.
- Regular lubrication — including lubrication of the circuit-breaker cam.
- Shock-absorbing drives to isolate the distributor from engine torsionals.
- Ignition coils of the sealed and oil-filled variety — which are durable and need only periodic inspection for proper lead attachment.

A chief improvement in ignition distributors has been to get the load on the bearings under control and to make proper provisions for lubrication. Also, distributor caps and rotors have been redesigned to handle the ignition voltage satisfactorily. Consequently, these units now have good life. Some delicate distributor parts have been isolated from high-accelerating torsional engine pulses by cushion drives. Thus, the fretting action which sometimes occurs has been greatly reduced. It is hoped that new distributor designs will reduce the overhanging of the breaker cam above the top of the main shaft bearing. This would improve the durability and accuracy of the performance.

To Order Paper No. 52B . . .
. . . on which this article is based, turn to page 6.

Lubricants

when subjected to

Viscosity changes, loss of oxidation stability, and development of corrosive tendencies are the main forms of damage.

Based on paper by

L. W. Manley, A. O. Pukkila, and E. G. Barry
Socony Mobil Oil Co., Inc.

TABLE 1 summarizes the effects of beta radiation on the lubricating oil base stock and finished products studied in our preliminary tests. These tests were run under static conditions with a Van de Graaff accelerator used as the radiation source.

Products containing polymeric V.I. improvers showed an initial decrease in viscosity, followed by an increase. This appears to be an example of cleavage, followed by crosslinking or polymerization.

When lubricating oil molecules become ionized, usually crosslinking or cleavage reactions take place. Crosslinking results in binding together of molecules in a network structure that is associated with:

- Liberation of gas.
- Formation of molecules larger than the original.

The cleavage reaction at the opposite extreme usually occurs when a double bond in a lubricating oil molecule receives sufficient energy to take up a hydrogen atom. This causes the molecule to split. The remaining fragments need only absorb another hydrogen atom to satisfy the molecule. The result is two molecules of smaller size, where originally there was one large one.

Synthetic oils of the type tested showed the largest increase in neutralization number. Several of the products developed corrosive tendencies, resulting from breakdown of additives contained therein. All the products investigated, with the exception of the synthetic lubricant, generated gas.

(It should be pointed out that much more work will have to be done in this field, for various reasons, among them being the following:

1. On an equal energy absorbed basis, there are some differences in product damage caused by electrons and gamma rays and indirectly by neutrons. See Figs. 1 and 2, which show differences in radiation damage caused by the three types of radiation.
2. Dynamic radiation tests are a much more realistic way of evaluating lubricant performance under specific conditions of speed, load, dose rate, and temperature than any static test can be.)

To Order Paper No. 53B . . .
. . . on which this article is based, turn to page 6.

Suffer

nuclear radiation

Table 1 — Effect of Radiation of Various Types of Lubricating Oils

MATERIAL	H.N.	VIS.	V.I.	OX. RES.	CORR.	MISC.
Base Oil	0	↑	↑	↓	↑ S 0 No S	Gas
Turbine Oil	0	↑	↑	↓	↑	Gas
Hydraulic Oil	0	↑↓	↓	↓	0	Gas
Auto. Trans. Fluid	0	↑↓	↓	↓	↑	Gas
Auto. Eng. Oil	↑	↑↓	↓	↓	0	Gas
Auto. Gear Oil	0	↑	↑	↓	↑	Gas + Sludge
Syn. Lube	↑	↑	↓	↓	↑	Sludge

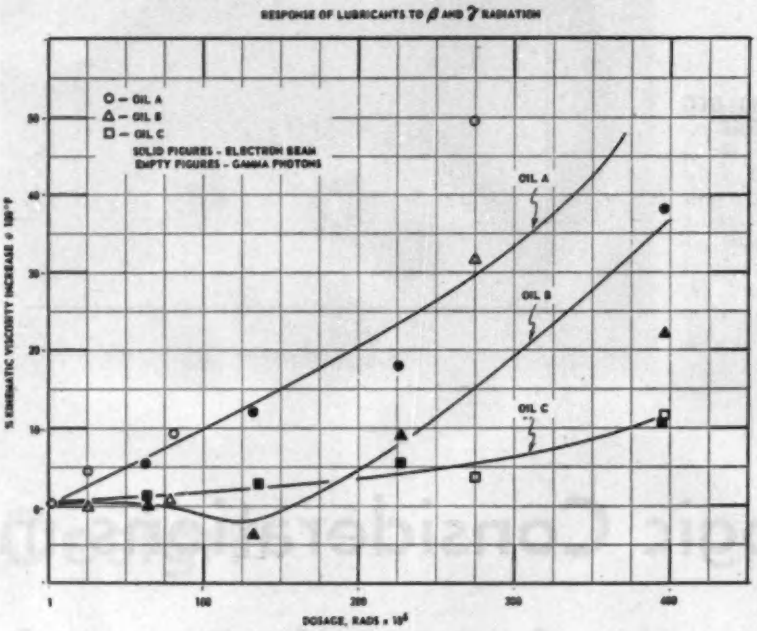

RESPONSE OF LUBRICANTS TO β AND γ RADIATION
O — OIL A
Δ — OIL B
□ — OIL C
SOLID FIGURES - ELECTRON BEAM
EMPTY FIGURES - GAMMA PHOTONS
OIL A
OIL B
OIL C
% KINEMATIC VISCOSITY INCREASE @ 100°F
DOSAGE, RADS × 10⁸

Fig. 1 — Viscosity increase versus absorbed dose for three oils having different degrees of radiation resistance. At a dose level of about 10^8 rads, oils B and C show only a slight viscosity increase, whereas oil A shows an increase of nearly 10%. Beyond 10^8 rads, oils B and C also show different degrees of radiation resistance.

Up to 2.3×10^8 rads, viscosity response to radiation shows good agreement with respect to gamma photons and beta rays. Beyond this value, a scattering of data appears, indicating that, perhaps, at higher dose levels, correlation of beta and gamma radiation damage is not as precise.

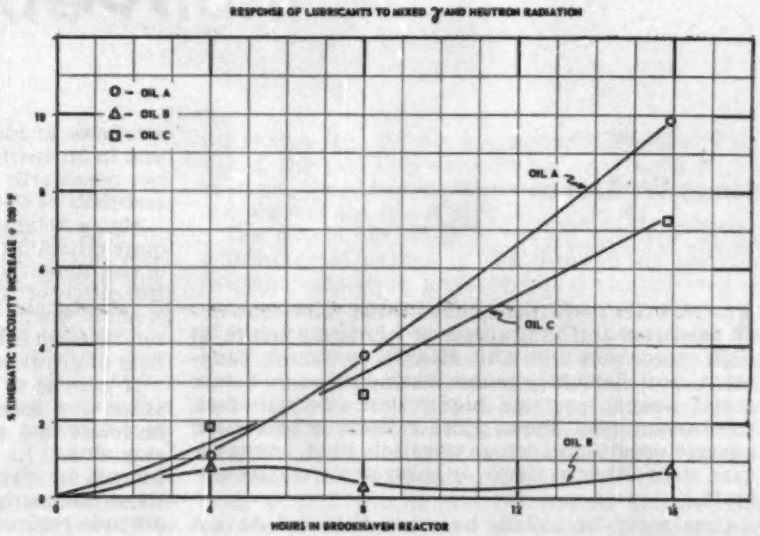
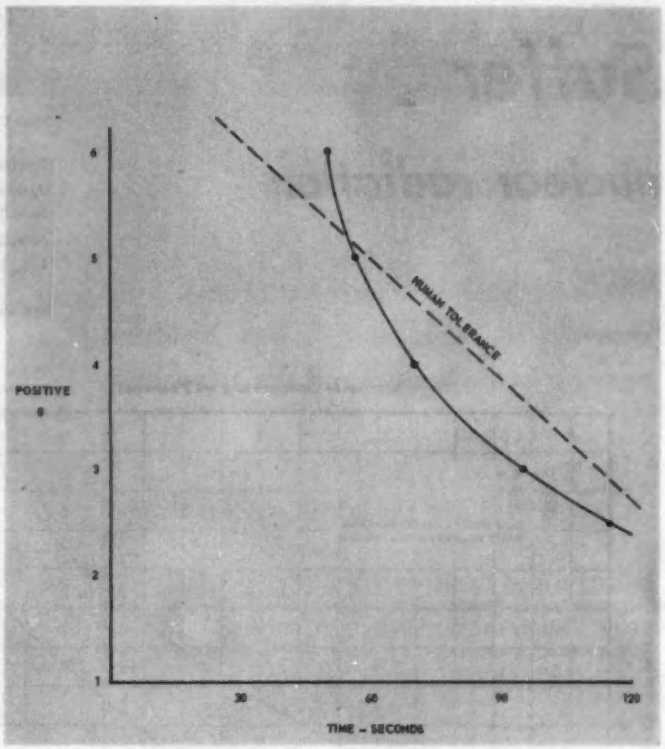

RESPONSE OF LUBRICANTS TO MIXED γ AND NEUTRON RADIATION
O — OIL A
Δ — OIL B
□ — OIL C
OIL A
OIL C
OIL B
% KINEMATIC VISCOSITY INCREASE @ 100°F
HOURS IN BROOKHAVEN REACTOR

Fig. 2 — Viscosity increase versus hours of mixed gamma and neutron bombardment in Brookhaven reactor. Direct measurement of neutron and gamma ray bombardment was not possible during this work. It might be assumed, however, that the time that the samples were in the reactor is directly proportional to energy absorbed, since reactor was operating at same power level all the time.



TO COMPLETE A 180 DEG TURN at 2000 mph without exceeding 3 g, it takes 98 sec — and 52 miles. Duration of the turn may be shortened, but only by incurring higher accelerative forces. Tolerances shown are for positive g with the subject protected by a standard Air Force anti-g suit and oriented in a conventional forward-facing, seated position.

7 Physiologic Considerations in for High-Speed,

Excerpts from paper by

James W. Raeke

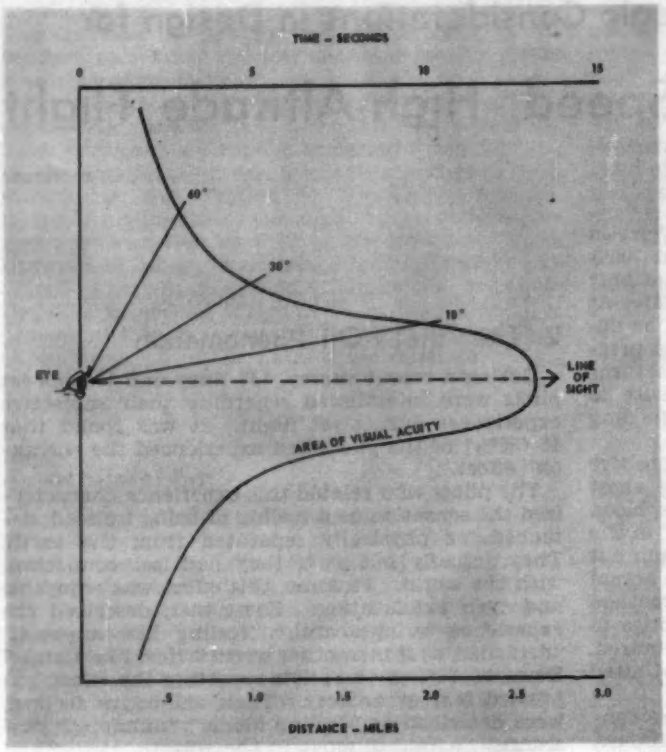
physiologist, Human Engineering Analysis Section
Northrop Division, Northrop Aircraft, Inc.

ALTHOUGH man has demonstrated numerous deficiencies and limitations in his performance at high speeds and high altitudes, his reasoning, judgment, and flexibility make his inclusion in future aerial weapon systems highly desirable. In fact, the human pilot shows more resistance to certain adverse conditions such as vibration, heat, and pressure than other systems or subsystems of the aircraft.

Care must be taken, however, that we do not attribute to him a capability to function at a rate and in an environment dictated by the machine but not necessarily consistent with his physical characteristics.

Man's tolerance to various stress conditions is quite critical in some respects, but the marked ability of the human to adapt and accommodate makes consideration of the man-machine relationship an extremely worth while endeavor. This man-machine relationship is the field of "human engineering" — a field of growing importance.

If man is to continue to be included as vehicles reach new speeds and altitudes, his tolerance must be found and aircraft performance programmed to stay within his capabilities. Here are seven of the human limitations that should be considered by those designing flight vehicles for 50,000–100,000-ft altitude regimes.



VISUAL ACUITY AT MACH 1 is 2.5 miles in the line of sight but only about 1 mile at an angle 30 deg from the line of sight. This is because visual acuity is sharper nearer the center of the visual field. The higher the speed, the more restricted the visual field in which it is possible to present the unaided eye with a target and still have time for initiation of a motor response.

Design High-Altitude Flight

1. Oxygen and Pressure Requirements

The decrease in atmospheric pressure with increasing altitude undoubtedly presents the most serious and difficult physiologic effect of high altitude flight. The most acute effect is the lowering of the partial pressure of oxygen as total atmospheric pressure decreases. Total oxygen deprivation, as in exposure to the ambient atmosphere above 50,000 ft, is thought to be capable of causing irreversible damage to central nervous tissue in approximately 30 sec.

Dry atmospheric air contains 20.94% oxygen regardless of altitude. At sea level pressure, the partial pressure of oxygen (pO_2) is equivalent to 159.14 mm Hg. As the atmospheric pressure is reduced, the pO_2 falls accordingly. At 18,000 ft, for example, the atmospheric pressure is reduced to 380 mm Hg and the pO_2 is only 79.57 mm Hg.

The pO_2 in the lungs is related not only to the percentage of oxygen in the inspired air and the ambient barometric pressure, but is also affected by the partial pressures of carbon dioxide (pCO_2) and of water vapor in the lungs. While the pCO_2 in the lungs decreases slightly with altitude, water vapor maintains a constant pressure of 47 mm Hg. The actual pO_2 in the lungs at sea level is therefore in the vicinity of 100 mm Hg. This pressure is sufficient to maintain the blood about 96% oxygen-saturated in a normal individual.

Up to altitudes of about 40,000 ft, an adequate oxygen saturation of the blood can be maintained

7 Physiologic Considerations in Design for High-Speed, High-Altitude Flight

. . . continued

by merely increasing the percentage of oxygen in the inspired air. At 40,000 ft, however, even 100% oxygen maintains a blood oxygen saturation of only 90% (equivalent to breathing air at 10,000 ft). At altitudes above 40,000 ft, 100% oxygen must be delivered to the lungs under sufficient positive pressure to maintain an adequate blood oxygen saturation, since the ambient pressure is inadequate to maintain necessary oxygen diffusion across the lung membrane.

Supplying oxygen to an individual under positive pressure causes a pressure imbalance in the chest cavity which in turn is transmitted to the blood circulatory system. Blood is caused to "pool" in the body extremities and as a result of being taken out of active circulation, has an effect similar to actual hemorrhage. To alleviate this condition, a method of applying external pressure to the extremities to balance the internal breathing pressure is required. This requirement led to development of the United States Air Force partial pressure suits.

The term "hypoxia" is used to identify the condition of insufficient oxygen in blood or body tissues. This condition is made more dangerous by its insidious onset at altitudes below 30,000 ft and its rapid development at altitudes above 30,000. At the altitudes of 50,000 to 100,000 ft, exposure to the ambient atmosphere would cause unconsciousness in 10–12 sec and possibly death in approximately 60 sec.

From the standpoint of the human operator, aircraft cabin pressurization is greatly preferred over personal pressurization as provided by a pressure suit. It would appear, however, that until the reliability of the individual's pressure environment equals the inherent structural reliability of the airframe, some type of personal protective gear such as a pressure suit will be required.

Controlling the pilot's immediate environment from the standpoint of pressure and composition will become increasingly difficult. For flights of very short duration, 30 min or less, environmental pressure and gaseous composition in the pilot's compartment could be accomplished by stored gases. The removal of contaminants such as carbon dioxide, water vapor, and excreted body gases would be unnecessary for this short period of time. For longer flights, both the available storage capacity and the need for relatively complex air-purifying equipment will become major problems.

At altitudes above 70,000 ft, pressurizing outside air becomes increasingly difficult, particularly in light of the power required for pressurization and the very high compressor exit temperature of the air due to the extreme pressure ratios. This will range from 700 F at 70,000 ft to 1100 F at 100,000 ft. The sealed cabin, equipped to maintain an artificial atmosphere to sustain life for extended periods seems the only answer.

2. The "Break-Off Phenomenon"

During a recent survey, 137 Navy and Marine jet pilots were interviewed regarding their subjective experiences during jet flight. It was found that 48 (35%) of the pilots had experienced the "break-off" effect.

The pilots who related this experience characterized the sensation as a feeling of being isolated, detached, or physically separated from the earth. They actually felt as if they had lost connection with the world. To some, this effect was enjoyable and even exhilarating. These men described the experience as "peaceful," "feeling like a giant," "detached, as if in another world," "feel like a king." However, 38% of the pilots reporting the effect, expressed fear or anxiety. Their subjective feelings were described as "feeling alone," "unhappy," "insecure," "afraid to move in the seat."

An additional sensation, often associated with the break-off effect but not considered crucial, is loneliness. Many of the pilots stated that they would rather fly at 20,000 ft, for instance, than 45,000 ft because "it's pretty lonely up there alone." Loss of radio contact with the base seems to accentuate these feelings.

No clear statement regarding the frequency of occurrence of the break-off phenomenon can be made from this one report. Certain common factors leading to the occurrence seem pertinent, however. The pilot was alone, at high altitude, and not particularly busy flying the aircraft when the effect developed.

3. Glare

During high altitude flight, there is usually present a cloud floor which becomes more uniform and extensive when viewed from greater heights. Most of the light reflected back into the aircraft then comes from below. Although some light does come from the sky above, it becomes progressively less as the aircraft goes to higher altitudes. The eyes, recessed as they are and located beneath overhanging eyebrows, are protected against the glare of sky light which normally comes from above. The cheeks give no appreciable restriction to the visual field and a light source located below the level of the eyes allows stray light to flood into them and cast a glare haze over the entire visual field. The pilot, being required to have a good view of the outside scene, is subjected to this glare with resultant ocular discomfort and reduced visibility of cockpit instruments and controls.

With increasing altitude, the contrast between

illuminated and shadowed areas becomes greater. This increase in contrast is due principally to the shadows becoming darker and not to the sunlit areas becoming brighter.

It is thought that even outside the earth's atmosphere, the shadows will never become absolutely black because they receive some light from neighboring illuminated areas, from stars, and even from interstellar dust (which is responsible for the intrinsic luminance of the night sky). It is therefore apparent that as long as cockpits have large transparent areas, increased emphasis will be required in providing adequate illumination to enable the pilot to see his instruments distinctly and yet protect him from adverse glare caused by reversal of the direction of the natural illumination.

4. Acceleration

An aircraft flying at Mach 3 requires 52 miles and 98 sec to complete a 180 deg turn and not exceed an acceleration of 3 g. The duration of the turn may be shortened, but only by incurring higher accelerative forces. Changing position from the conventional forward-facing one, so that the acceleration is sustained as transverse g, as in the case of the prone or supine position, will allow the g-suited subject to withstand at least two to three times the tolerable positive g limit. This physiological fact has caused considerable interest in the utilization of the prone or supine position for the pilot as a means to enhance the performance capabilities of future manned aircraft.

5. Empty Field Myopia

The cloudless blue sky fails to produce any impression of depth or distance due to the absence of any visible detail in the visual field for the eye to focus on. In this case, the eye will come to a resting focus somewhat short of infinity, thereby greatly minimizing the ability of the eye to pick up a distant aircraft as in air-to-air search. It is not unusual in such a case for a pilot to realize suddenly that his eyes are not focused in the distance but on spots of dust on the windscreen. Even with recognition of this visual limitation, the estimation of size, distance, and relative speed of another aircraft is impaired by the lack of clues from parallactic displacement in the cloudless sky.

6. Visual Acuity

Since visual acuity is least in the periphery of the visual field and is sharpest nearer the center, an object in the periphery has to be nearer before it can be recognized. This makes the field of vision cone shaped, the apex being away from the eye and on the line of fixation.

The effect of higher speeds is to restrict the field of view in which it is possible to present the unaided eye with a target and still have time to initiate a motor response. It is obvious that as the visual fields become smaller, there will eventually be reached a speed at which time for operator reaction will be longer than the flying time taken to reach the target. In such a case, there would be no possibility of taking evasive action unless the visual range was increased artificially. The inadequacy of man's ability to cope with high speeds is revealed by the following example taken from an article by H. Mosely and V. Steinbridge in the December 1957 issue of the "Journal of Aviation Medicine":

"The pilot of a jet bomber was flying at 30,000 ft on a clear morning. He made a slow turn and was startled to see three other bombers approximately 1 mile away and on a collision course with him. Before he could react or alter the course of his aircraft he shot through the formation, missing the nose of the first aircraft, flying under the second, and over the third. As he went over the third bomber, one of his engines struck the upper part of this bomber's tail and knocked it off. The pilot who flew through this formation then returned to his home base, landed, and recounted his experience. Inasmuch as no report had been received from the formation he had flown through, it was called and requested to land. When it landed it was found that the formation consisted not of three aircraft, but of six. The aircraft whose tail had been hit was not significantly damaged, but what is amazing is that neither the pilot, the co-pilot, nor the observer in any of the six aircraft had seen the other bomber fly through the formation."

7. Cosmic Radiation

A problem difficult to assess with current data is the danger of exposure to cosmic radiation. The general opinion among investigators seems to be that the previously considered dangers have been over-emphasized.

The risk of inducing gene mutations by cosmic radiation at high altitudes does not appear to be serious enough that anyone engaged in high-altitude flight (not space flight) need worry about it for himself or his descendants. It is certainly a risk several times less than that which people take in being exposed to medical X-rays.

Over all, the potential biological and medical hazards of cosmic radiation are not particularly alarming, especially for flights of such brief duration as may be achieved in the near future. Further investigation will make clear either that it does not constitute an appreciable biological hazard or that it constitutes an assessed hazard, which must be accepted along with such other hazards of an engineering or human nature which attend high-altitude flight. The current opinion suggests that cosmic radiation does not represent an overwhelming obstacle to high altitude and eventual space flight.

To Order Paper No. 398 . . .
. . . on which this article is based, turn to page 6.

DELRIN—

A New Thermoplastic

- - offers high strength, excellent thermal stability, good fatigue life, low creep, and excellent solvent resistance.

Based on paper by

H. H. Goodman and J. D. Young

E. I. Du Pont de Nemours & Co., Inc.

MADE FROM FORMALDEHYDE is a new plastic called Delrin acetal resin. Difference from previous resins of formaldehyde is that it has very long chains and excellent thermal stability. Delrin offers high strength, good fatigue life, low creep, and excellent solvent resistance. It retains these properties at elevated temperatures.

In Delrin, the formaldehyde units are combined in long, unbranched chains normally averaging more than 1000 formaldehdye units. The generic name, acetal resin, comes from the fact that the chain is made up of repeating carbon-oxygen units.

Because of the nature of the carbon-to-oxygen linkages in this polymer, the chains can pack closely together in a dense, uniform pattern. As a result the chains arrange themselves into strong, solid crystals interspersed with small areas of amorphous material (Fig. 1).

This dense crystalline structure is responsible for many of the key properties of Delrin — especially strength and stiffness, high-temperature behavior, and solvent resistance.

Let's consider some of these physical properties in more detail. At room temperature, Delrin has an elongation of about 16% and a tensile strength of 10,000 psi. The effect of temperature on these properties is shown in Fig. 2. Note that as the temperature is increased, tensile strength falls off while elongation increases. Even at 250 F, however, the tensile strength of Delrin still exceeds that of any of the present commercial thermoplastics.

Fig. 3 shows flexural modulus plotted against temperature for various humidity conditions. The modulus value in the range from 40–300 F is among the highest available in present thermoplastics. The difference in stiffness under extremes of humidity is small at room temperature and practically nonexistent at elevated temperatures.

All plastics exhibit gradual deformation called creep or cold flow when they are subjected to a continuously applied load. This creep does not continue indefinitely at a constant rate but levels off as the time increases. Fig. 4 shows the creep characteristics of Delrin under 1500 psi stress for various temperatures.

If the load is removed, the inherent elasticity of the material will effect nearly complete recovery in time. Thus, the amount of deformation which will occur in a part that is loaded intermittently is dependent upon the amount of load, the length of time under load, and the length of time no load is applied. Fig. 5 shows the result of loading bars of Delrin to the indicated tensile stresses for 5 cycles, with the load being removed after each cycle. At stresses below 5000 psi there was negligible permanent deformation.

At normal temperature and humidity, Delrin exhibits approximately the same creep behavior as the most rigid of the present thermoplastics. But at elevated temperature and humidity, this acetal resin exhibits exceptional resistance to creep.

Infinite Fatigue Life

When subjected to a repeated cyclic stress, all materials will ultimately fail at a stress lower than the apparent tensile strength of the material. This phenomenon is known as fatigue failure. Experiments reveal, however, that there is a stress value below which Delrin will not fail, regardless of the number of times the load is applied. This stress is called the fatigue endurance limit. Fig. 6 shows the fatigue life under two environmental conditions. Thus, at 150 F and 100% relative humidity, Delrin will have an infinite fatigue life as long as the stress level does not exceed about 3000 psi.

For its stiffness, Delrin is a very tough, resilient material. However, it cannot take as much deformation as the more flexible materials like nylon or polyethylene. When thinking about the toughness or resilience of this material, it should be compared to the resilience of a steel spring rather than the elasticity of a rubber ball.

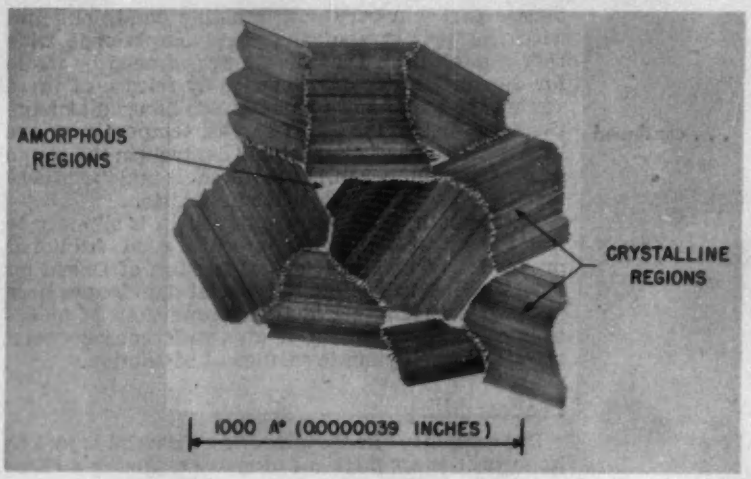


Fig. 1 — Crystalline and amorphous structure of the Delrin acetal resin chain.

Izod impact tests on unnotched bars of polyoxymethylene show it to have an impact strength of about 20.5 ft-lb per in. Notching the bar reduces the impact strength to about 1.4–1.6 ft-lb per in. Although this latter value is still quite good for a rigid thermoplastic, the marked drop in impact strength emphasizes the need to eliminate sharp corners and other stress raisers in designing parts of Delrin.

The effect of temperature on the notched izod impact strength of Delrin is shown in Fig. 7. Note that even at temperatures down to – 40 F, there is little loss of impact strength. Thus, all of the toughness and impact data lead to the conclusion that Delrin is tough in the sense of being strong and rigid. It should be used where high strength and resistance to bending is required and not where severe deformation must be tolerated in service.

Dimensional Stability

Dimensional stability is an important property of any engineering material. Dimensional changes in plastic materials are caused by four major factors:

1. Expansion or contraction resulting from temperature changes.
2. Volumetric changes resulting from water or solvent absorption or loss.
3. Changes in shape due to stress relief.
4. Deformation under continuous loading.

The effect of temperature on Delrin is defined by the coefficient of linear thermal expansion which is 0.00005 in. per in. per deg F. This value is approximately equal to that of most other plastics. This coefficient is several times greater than that of ferrous and nonferrous metals, a factor which must be taken into account in part design.

The effect of moisture and other solvents on dimensions, as well as strength properties, is shown in Table 1. Test length varied from 180–365 days, and exposure from 122–158 F. In all cases, the per cent change in tensile strength and length are relatively minor.

Locked-in stresses in an injection-molded thermo-

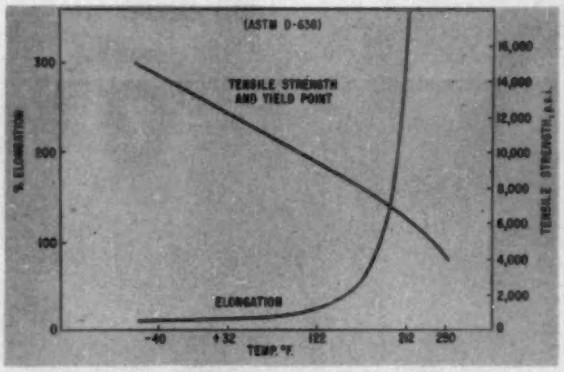


Fig. 2 — Effect of temperature on the tensile properties of Delrin. At 250 F, the tensile strength still exceeds that of the commercial thermoplastics.

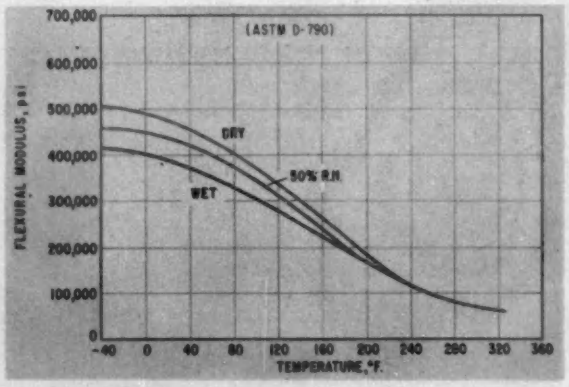


Fig. 3 — The flexural modulus of Delrin in the range from 40-300 F is among the highest available in present thermoplastics. The difference in stiffness under extremes of humidity is small at room temperature and practically nonexistent at elevated temperatures.

DELRIN —

a new thermoplastic

. . . continued

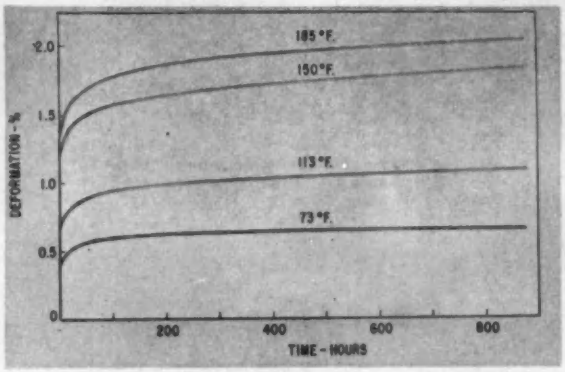


Fig. 4 — Deformation curves for Delrin stressed to 1500 psi.

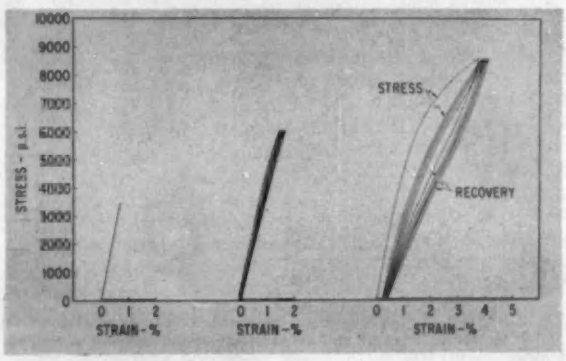


Fig. 5 — Tensile stress and recovery of Delrin under repeated loadings. Bars were loaded for 5 cycles to a given tensile stress with load being completely removed after each cycle.

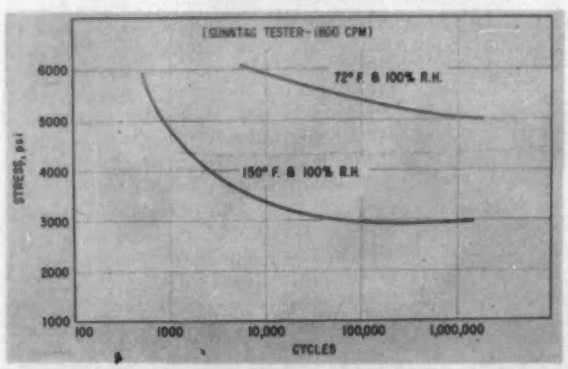


Fig. 6 — Delrin reaches a stress value below which it will not fail regardless of the number of times the load is applied. Influential factors on this stress value are temperature and humidity.

plastic part will vary with molding conditions and with the geometry of the part. Experience with Delrin has shown that no allowance need be made for dimensional changes caused by release of these stresses so long as the parts are to be used at temperatures below 120 F. If service temperatures are higher and if close dimensional control (in the range ± 0.001–0.003 in. per in.) is required, it may be necessary to anneal the parts after fabrication.

The smooth, hard surface of Delrin is slippery to the touch, which would indicate good frictional properties. The coefficient of friction of Delrin on steel is shown in Table 2. Of special significance here is the fact that under identical conditions of measurement, there is little, if any, difference between the static and dynamic coefficient of friction.

Processibility

Processibility of an engineering material is just as important as its physical properties. Being a thermoplastic, Delrin can be easily fabricated into complex shapes by standard injection-molded techniques. Parts successfully molded include internal and external threads, undercuts, helical gears, wall sections from 0.04–0.375 in., and larger pieces weighing up to 2½ lb.

Delrin can be extruded into a variety of shapes and forms. The material can be handled on conventional equipment used to extrude other thermoplastics.

Delrin can be machined by conventional metalworking techniques such as sawing, milling, turning, reaming, threading, and tapping. The machinabil-

Table 1 — Resistance of Delrin Acetal Resin to Selected Fluids

Material	Test Length (days)	Test Temperature (deg F)	Tensile Strength (% change)	Length (% change)
Heavy Mineral Oil (Nujol)	365	158	+2	−0.4
Motor Oil — 10W30 (Uniflo)	365	158	+3	−0.3
100% Aromatic Fuel (toluene)	365	122	−7	+1.2
Ethyl Alcohol, 100%	365	122	−5	+1.0
Acetone	365	122	−7	+1.1
Brake Fluid (Super 9)	365	158	−6	+0.6
Water	275	140	+2	+0.5
10% Salt in Water	180	158	0	0

Table 2 — Coefficient of Friction of Delrin on Steel

Conditions	Coefficient of Friction[a] Static	Dynamic
Dry (73 F)	0.1–0.3	0.1–0.3
Dry (250 F)	0.1–0.3	0.1–0.3
Lubricated with Water (73 F)	0.2	0.2
Lubricated with Oil (73 F)	0.1	0.05–0.1

[a] Measurements were made by the inclined plane method.

ity of the material can be compared to that of soft brass.

Delrin can be joined to itself or to other materials by a wide variety of techniques. Several forms of welding may be used. These include hot-plate welding, hot-gas welding, resistance-wire welding, induction welding, and spin welding. In the latter case, the heat required to melt the material to effect the bond is generated by rotational friction. Bonds formed by these methods have in many cases approached the basic strength of the material itself.

Data to date indicate that mechanical fasteners such as self-tapping screws, bolts, explosive rivets, and other types of rivets will give very strong joints. In one particular test, a 400-lb pull was required to remove a self-tapping screw from a piece of Delrin. The high creep resistance of the material should insure that joined pieces will remain tight.

Two other methods of joining make use of the resilience of the plastic; these are snap fits and interference fits.

Several of the applications visualized for Delrin will require some sort of finishing. Since the material is naturally a white, translucent color, it can be integrally colored by pigmentation in a wide range of shades and hues. Where painting is desirable, suitable techniques are available for this new plastic. Its good temperature resistance will permit bake-outs at 300 F to insure good adhesion and a durable surface.

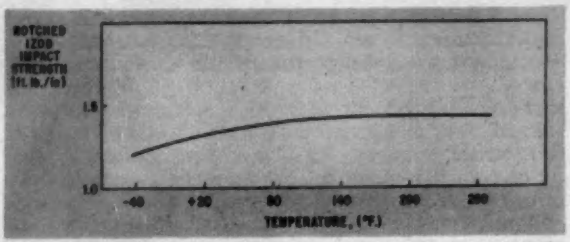


Fig. 7 — Effect of temperature on notched izod impact strength of Delrin.

To Order Paper No. 60A . . .
. . . on which this article is based, turn to page 6.

Will Elusive Fusion Power . . .

. . . become commercially feasible before our supply of fossil fuels is exhausted? . . . here's the answer of one Princeton physicist doing fusion research.

Based on a report by

J. F. Black Esso Research & Engineering Co.
(to the SAE Nuclear Energy Advisory Committee)

IT WILL BE 20–30 years before a fusion device is built that will be able to produce more power than it consumes, according to Dr. Thomas Coor, Jr., Research Staff, Project Matterhorn, Princeton University[1]. And it won't be for some good time after that that the fusion reaction will be capable of producing power at a profit. By that time, he feels, fossil fuels will be very scarce.

Two of the problems mentioned by Dr. Coor as facing workers in the field are:

- The direct conversion of fusion into electricity.
- Neutron activation in fusion reactors.

One of the advantages cited for the fusion process is the possibility of converting fusion power directly into electricity by operating upon the ionic plasma (gas so exceedingly hot as to be completely ionized into positively charged nuclei or ions and into negatively charged electrons). For example, the plasma is diamagnetic in nature and reacts against an imposed magnetic field. By compressing the plasma magnetically and then allowing it to expand, electricity can be produced through a magnetic equivalent of the Carnot cycle.

Many problems remain to be solved, however, in order to accomplish such an effect. For example, fusion research is now concerned with the reaction of deuterium with tritium. The main yield from this process is helium and neutrons. Unfortunately, only 20% of the fusion energy appears in the form of helium ions. Eighty per cent of the energy is obtained as kinetic energy of the 14 mev neutrons which are created in the process. This neutron energy cannot be converted directly into electricity but must be changed into heat, which would produce electricity by the usual thermal processes.

In the future it may be possible to produce fusion by the interaction of deuterium ions. Eighty per cent of the energy of this reaction would be produced as ions in the plasma and only 20% would be lost through neutron production. Unfortunately, however, the reaction between deuterium nuclei is much more difficult to initiate than that between deuterium and tritium, and at present no one can predict when it can be done.

One potential advantage of the fusion process for large-scale power production is that no radioactive fission byproducts are produced. This advantage is important since many people feel that waste disposal problems may eventually limit the amount of power which can be produced using fission reactors. It does not mean, however, that radioactivity would be no problem in the vicinity of fusion devices. Dr. Coor stated that the neutron flux produced by a fusion device will, in all probability, be greater than that derived from a fission reactor of comparable power output.

He went on to say that predicted designs had been drawn up for a fusion-based power plant of appreciable electrical output. The details of these designs are still classified. He could state, however, that if the plant were unshielded the neutron flux would be sufficient to prove fatal to the passengers in an airplane which was flying over the plant at an altitude of 1 mile.

[1] This information was presented by Dr. Coor on May 20, 1958 at a meeting of the Metropolitan Section of the American Nuclear Society in New York.

Free Radicals for Propulsion . . .

. . . offer high energy content, but for the present the weight of the total powerplant and fuel tanks makes them impractical. Research now under way, however, may enable aircraft or space vehicles to use free radicals in the future.

Based on paper by

Y. C. Lee,
Director of Research, and

S. T. Demetriades,
Consultant
Aerojet-General Corp.

THE high-energy content of free radicals makes them attractive as sources of energy for flight propulsion. But free radicals present problems that preclude their use as propellants at this time.

With solid free-radical propellants the problems include diluent losses, storage penalties, and dissociation losses.

With gaseous free radicals, such as the atomic oxygen found at 60-mile altitudes, the length of the catalytic bed needed to recombine the atoms would create too much drag for the powerplant to overcome. It might be possible, however, to recombine the atoms by compression, if the speed of recombination is great enough. Aerojet-General is investigating the possibility.

New free radicals may in the future be useful in a solid, liquid, or gaseous form — we cannot say with certainty yet. What we can say is that the engine weight will vary depending on their state. Table 1 gives a list of the energy released per gram or per mole of the parent species when the indicated free radicals, excited atoms, or molecular fragments are allowed to form the parent species. Table 1 is highly idealized in the sense that it does not allow for dissociation. It assumes that the entire quantity of free radicals in question is converted into the parent species. For reference, the heat of combustion of $H_2 + O_2$ at a mass ratio (oxidizer/fuel) of 3.5 (for maximum specific impulse) is shown in Table 1.

The performance (that is range capability with given payload or payload capacity with given range) of a jet-propelled vehicle of given size varies with the energy content per unit mass of the fuel H_c. Other things being equal (namely the ratio of gross weight minus fuel weight), the range for a ramjet is directly proportional to H_c while for a rocket the range (in the 1000- to 5000-mile interval) is approximately proportional to the three-halves power of H_c. Therefore, an obvious way of improving the performance of a rocket or ramjet is to increase the energy content of the fuel it burns. Another, not so obvious, result of this increase in energy content of the fuel is the decrease in gravitational losses due to the decrease of the burning time of the motor.

However, any scheme for increasing the performance of a powerplant by increasing the energy content of the fuel involves various penalties such as penalties in structural efficiencies, handling, storage. These inherent and systematic penalties operate on the performance equation in such a way as to cancel in part the advantages gained by the increase in H_c.

The upper limit in the gain in performance due to any free-radical fuel can be established by an analysis of the system necessary to utilize this fuel. Therefore, in principle, one may study analytically the performance limits and other penalties associated with the use of free radicals and other high-energy fuels.

Here is a partial summary of some of these disadvantages which cancel in part the gains resulting from the higher energy content of the propellant.

Table 1 — Energy Content of Free Radicals

Species	Kcal/g of Products
$H + H \rightarrow H_2$	51.21
$O + O \rightarrow O_2$	3.66
$N + N \rightarrow N_2$	8.03
$CH_3 + CH_3 \rightarrow C_2H_6$	2.77
$N + 3H \rightarrow NH_3$	16.26
$F \rightarrow F_2$	0.94
$C + 4H \rightarrow CH_4$	22.66
$CH_3 + H \rightarrow CH_4$	6.30
$H + OH \rightarrow H_2O$	6.55
$H + NH_2 \rightarrow NH_3$	5.99
$Ne^* \rightarrow Ne$	18.83
$He^* \rightarrow He$	113.17
$4.6H_2 + O_2 \rightarrow 2H_2O + 2.6H_2$	2.8[a]

[a] Mixture (weight) ratio for maximum specific impulse.

solid propellants

Diluent Losses — Since the propellant must be in the solid state to avoid random motion of and collision between free radicals, the structural characteristics of a free-radical rocket will be similar to those of a solid-fuel rocket. Thus, whereas a liquid rocket has a ratio of weight of structure to weight of propellant plus structure of about 0.09, the same ratio for a solid-fuel rocket is about 0.14. In addition, the low temperatures involved in storing free radicals imply extensive use of insulation and cooling or heating coils through most of the structure. This produces a significant increase of the structural weight.

Storage Penalties — In order to maintain the fuel in the solid state over a short period of time, liquid-helium cooling jackets will be necessary since even a small pocket of liquid free radicals will lead to an explosion. To maintain the propellant in the solid state over longer periods of time, extensive liquid-helium installations (helium cryostats) may prove necessary. The heat of vaporization of helium is 6 cal/g and a helium cryostat weighing 5000 lb produces only 9 l per hr. The density of liquid helium is 0.147 g/cc; therefore the production of liquid helium is 22 g/min. This is equivalent to about 132 cal/min. Solar radiation alone provides about 2 cal/cm²-min at the distance of the earth from the sun. Therefore, the maintenance of a container with an exposed surface of many-thousand square centimeters at liquid-helium temperatures would require the installation of cooling equipment weighing many thousands and probably tens of thousands of pounds. This almost precludes the use of radicals for sustaining interplanetary flight.

Thermodynamic and Thermal Penalties — The ideal combustion temperatures (neglecting dissociation) associated with free-radical fuels are approximately 10,000 K. At these temperatures a considerable part of the energy released will go into ionizing and dissociating the reaction products; therefore the real reaction temperature will be lower. As a consequence, only part of the gain in the energy content of the fuel by use of free radicals will be converted into a gain in the kinetic energy of the products; that is, the thrust will increase by a smaller proportion than the energy content. It is estimated, for example, that in the system $4H + O_2$ about 50% of the available energy goes into dissociating and ionizing the products. Nevertheless, the temperature is still higher than in the corresponding $2H_2 + O_2$ system. Therefore, the problem

Table 2 — Comparison of Hypothetical Free-Radical System with $H_2 + O_2$ System

System	Motor	Mixture Ratio	Specific Impulse, sec	Mass Ratio[a]	Escape Number[b]
Solid H_2 matrix with H included	Solid-propellant	$H + 3H_2$	600	0.28	0.68
Liquid $H_2 + O_2$	Liquid-propellant with regenerative cooling	$4H_2 + O_2$	340	0.05	0.89

[a] Mass ratio is defined as $\frac{\text{total weight} - \text{fuel weight}}{\text{total weight}}$

[b] Escape number is defined as $\frac{32.2\,(\text{specific impulse})\log_e(1/\text{mass ratio})}{\text{escape velocity from earth}}$

Free Radicals for Propulsion

... continued

of containing the reaction becomes very severe, especially since this propellant cannot be used for regenerative cooling. Preliminary computations indicate that these effects would add as much as 100% on the weight of the casing or motor and on the nozzle.

Conclusions — When all these disadvantages are compounded, the specific impulse of a free-radical solid-propellant system is decreased by a large factor (a 70% decrease is typical) and the mass ratio (defined as the ratio of inerts to inerts plus propellant) is increased by a large factor. A 100% increase is typical. As an example, consider a free-radical propellant with a specific impulse of 1200 sec. Then the real specific impulse of a realistic solid propellant using that free radical would be about 600 sec while its mass ratio would be about 0.28. Table 2 shows a comparison of a hypothetical free-radical system with a liquid nitrogen–liquid oxygen system. These figures are not very encouraging: the escape number is actually smaller for the free-radical system.

liquid propellants

Since the mobility of free radicals in liquids is not well known, but is presumed large, this type of powerplant does not appear promising at this time.

gaseous propellants

In this case, the free radicals remain free for long periods of time by keeping the frequency of collisions low through low-pressure operation. These powerplants will be generally too large for most practical uses. As an example, consider the utilization of atomic-oxygen recombination in the upper atmosphere. At the earth's surface, the oxygen in the atmosphere is present in the form of molecules consisting of two atoms each. At altitudes above 60 miles, nearly all of the oxygen molecules are split into atoms by the action of ultraviolet light from the sun. Thus the atmosphere at altitudes of 60 miles and above consists of a mixture of oxygen atoms and nitrogen molecules. Since oxygen atoms release a large amount of energy when they combine to form molecules, the layer of atomic oxygen in the upper atmosphere represents a storehouse of solar energy which is potentially available for propulsion and other purposes.

The most direct method of using the stored energy for propulsion is by means of a ramjet, that is a duct or tube moving through the atmosphere at high velocity. The atomic oxygen in the air entering the forward end of the duct is made to recombine into molecules within the duct, releasing its energy and heating the gas stream. Part of this energy is used in raising the pressure and velocity of the gas issuing from the rear of the duct, creating a thrust tending to propel the ramjet forward.

The atomic oxygen may be made to recombine by two methods: either by passing it over catalytic metal surfaces within the powerplant, or simply by compressing the gas stream. Since the density of the atmosphere at an altitude of 60 miles is extremely low — about one millionth of its sea-level value — the available thrust is quite small. But the drag is also very small for the same reason, and a ramjet flying at speeds of several times the speed of sound could easily produce enough thrust to overcome the drag. A ramjet flying at this speed would have to be made of extremely light materials such as thin metal foil, since the lift produced per unit area of wing surface is also extremely small at 60-mile altitude.

Prof. Paul Harteck of Rensselaer Polytechnic Institute is investigating the possibility of constructing a vehicle of this type to fly at about twice the speed of sound, using a catalytic powerplant. Since it would not have to carry any fuel, it could stay in the air indefinitely. Because of the extremely lightweight construction required, such a vehicle would have to be unmanned, but it would be useful for such purposes as a reflector for television or microwave signals.

In Aerojet-General's Astronautics Laboratory at Azusa, Calif., a different method of utilizing the energy stored in the atomic-oxygen layer is being investigated under a contract from the Air Force Office of Scientific Research. If the atomic-oxygen ramjet can be made to fly at orbital speed (18,000 mph) no lift will be required, and heavy payloads of men and instruments can be carried in orbit at 60-miles altitude indefinitely, provided the drag can be made smaller than the available thrust. No fuel would be required; the atomic-oxygen satellite would extract sufficient energy from the atmosphere to overcome the atmospheric drag.

Preliminary calculations indicate that it will not be easy to reduce the drag to a low-enough level to make the orbital, atomic-oxygen ramjet feasible, but the possibility is not yet definitely excluded. At orbital velocity, recombination will have to be brought about mainly by compression. A purely catalytic powerplant is ruled out because the catalyst surface required would produce too much drag.

A critical factor in the design of such a powerplant is the speed of recombination of the oxygen atoms. If it is too small the duct will have to be so long (to allow sufficient time for recombination to take place) that its drag will be excessive. An experimental program is underway at Aerojet-General to measure the rate of recombination. A theoretical estimate has been obtained for use in the preliminary design calculations, but experimental verification is required.

We see, therefore, that the problems facing the atomic-oxygen powerplant are formidable: at orbital speeds the drag is too high; at sub-orbital speeds the lift is too small. A solution, however, is not definitely excluded. Other than conventional uses of the dissociated-oxygen layer may be found.

To Order Paper No. 41C ...
... on which this article is based, turn to page 5.

Making the Jet Transport Pay . . .

. . . will require better instruments, flight control, and ground handling.

Based on paper by

J. T. Dyment

Trans-Canada Airlines

EXISTING operational and instrument tolerances can exact severe penalties in the performance of future jet transports. These penalties can show up as power loss, shorter range, and smaller payload.

Three main sources of lost performance are ground handling, accuracy of flight instruments, and flight path or weather changes.

Variations in Ground Weight

More than 7000 lb of payload can be lost if all ground weighing errors are on the negative side. This total breaks down as follows:

Weighing Operation	Accuracy, %	Error, lb
Aircraft weighing machines (empty)	0.1–0.5	600
CAA fleet average tolerance (max load)	0.5	970
Weight growth due to modifications		200/year
Fuel quantity (full tanks)	2–3	2800
Crew and equipment		100
Passengers (all male)		2030
Baggage	2	130
Cargo	4	320

This is for a 300,000-lb jet transport carrying 140 passengers and 140,000 lb of fuel. It would fly at Mach 0.8 and cost approximately $900/hr to operate.

Instrument Errors Cost Performance

Not considering reading errors, today's instruments can seriously cut into the performance of jet transports. In some cases new instruments have already been developed and could be installed. The penalties resulting from the more critical instruments are shown in Table 1.

Penalties for Flight Plan and Weather Changes

TWA reports that a 60-knot headwind will cost 13,500 lb more fuel on the New York-Paris run in a Boeing 707-320. This is typical of the severe penalties that the jet transport will encounter if it doesn't stay close to optimum conditions.

Other examples of lost fuel in a 300,000-lb jet are:

- 1096 lb of fuel if climb is interrupted for 30 min at 20,000 ft, or 917 lb if a 10-min interruption occurs at 10,000 ft.
- If climb is in 2000-ft steps to the optimum altitude 1451 lb of fuel will be lost. The price of 4000-ft steps is 1704 lb of fuel.
- 2242 lb of fuel are required to fly a parallel course 120 nautical miles away, with no change in atmospheric conditions.
- Descent paths are flexible but holding with flaps can use 30–40% more fuel than holding without flaps. The present piston-engine holding pattern would use 38% more fuel than a race track pattern, 18 × 7 miles, at 30,000 ft.

Hot weather will be hard on jet operation. A 40 F increase in temperature over standard temperature will seriously affect take-off and cruise performance.

For take-off, the 40 F temperature rise will

Increase —

- Take-off distance 30%.
- Fuel consumption 2%.
- Take-off true airspeed 4%.

Decrease —

- Thrust 16%.
- Allowable weight 10%.

Cruise performance suffers from high temperatures as well:

- A 20 F temperature rise will cut thrust 11%, and maximum payload *or* range by 25%.
- A 40 F rise reduces cruise thrust 22% and increases ground specific fuel consumption 2½%.

To Order Paper No. 50C . . .
. . . on which this article is based, turn to page 6.

Table 1 — Penalties for Instrument Inaccuracy

Instrument	Penalty
Altimeter (existing): 700 ft error over 25,000 ft	2000-ft separation between flight lanes — fewer and less efficient lanes
Altimeter (new): ± 80 at 30,000 ft	Existing 1000-ft separation O.K.
Airspeed (existing)	± 8 knots
Airspeed (new)	± 2 knots
Outside temperature: ± 1 C	700 lb less take-off weight or 150 ft extra runway length
Machmeter: 1% error	Other flight instruments will have to be used until a more accurate instrument is developed
Fuel flow (existing): 7% total error	850 lb fuel/hr
Fuel mass flowmeter (new): 3% overall error	2700 lb fuel for a trans-Atlantic flight
Thrustmeter: 5–7% error	Increase take-off distance approximately 9%

A first-hand report by a recent visitor to Russia shows high quality of . . .

Russian Research and

Based on a report by

T. W. Lippert

Director of Marketing, Titanium Metals Corp. of America
(to the SAE Science-Engineering Advisory Committee)

A MONTH-LONG trip to Russia as part of a group invited by the Moscow Steel Institute formed the basis for Mr. Lippert's observations, as presented here, on Russian:

- Research and publications.
- Metals industry.
- Education.

Two conclusions are apparent from the author's remarks:

- Russia is lush with research programs, facilities, and personnel — all of which he rated as excellent.
- Recognition and incentives given scientists and engineers attract the elite of their young people and furnish a climate conducive to highly productive work. Results of Russian research and engineering prove that the care and feeding of technical people are paying off in Russia.

Among the specific observations reported by the author was the fact that, although the Russians are quite open about their ferrous metallurgy and steel-making facilities, they are secretive about light metals and nuclear developments.

• Mostly about Research and Publications

RUSSIA'S ACADEMY OF SCIENCE theoretically maintains complete control over research. Actually, this control is fairly loose, for Russian research laboratories spend only 20–40% of their time working on these programs from above. The rest of the time they are free to follow their own inclinations. As a result there is considerable duplication of research — just as in our laboratories — and empire building is not unknown.

RUSSIAN RESEARCH is a very pampered area and research people are an elite group in Russian society. The research worker is supplied with as many people and with whatever equipment he wants, just for the asking. As a result, the profusion of equipment is almost unbelievable. This means also that no matter how many scientific and technological graduates there are, there is work for them in Russia's all-out research programs.

PERSISTENT DIGGING MAY BE NEEDED on a trip to Russia to find out the really important work that is being done in various technological fields. In many areas the Russians don't want to talk, and it may take real ingenuity to find out what they are doing. But whenever one succeeds in getting beneath the surface in a particular area, one is apt to be impressed.

RUSSIAN ACADEMY OF SCIENCE MEMBERS — academicians, as they are called — there are 158 of them — are very highly regarded, even at the Kremlin, where they are sometimes called for consultation.

Engineering

MOST RUSSIAN RESEARCH LABS have an official 6-hr day . . . for some it is as low as 4 hr. Work week is 6 days, but there is talk of lowering it to 5 days.

SAE JOURNAL and many other foreign technical publications are published in Russia directly (by photooffset) usually within one month of their original publication date. I saw over 80 such magazines in my travels in Russia. The English version of the Journal of Metals (published by the American Institute of Mining and Metallurgical Engineers) is reprinted in greater quantities than in the United States. The Russian technical man has studied upwards of 12 years of English and is usually quite adept at reading — and comprehending — such material. Abstracts are also made of all technical articles, and the complete papers are translated into Russian.

THAT's WHY Russian Engineers and scientists are much more aware of what's going on in this country by way of research programs, engineering developments, and personalities in their specialized fields than we expect. In turn Russian scientists and engineers are professionally irritated because our people don't know what they are doing.

BEING A DICTATORSHIP, Russia can mount massive drives in any area of technology with great speed. This is explained in part by ready availability of financing and in part by Russia's ability to direct the flow of engineers where needed. Russia is soon to launch a tremendous internal building and construction program.

RUSSIANS are great for "one-up-manship" — if you can do something, they can do it better, or bigger, or faster, or something.

• Mostly about the Metals Industry

RUSSIAN METALS PLANTS are making extensive use of:

- Vacuum melting.
- Continuous casting.

RUSSIAN FERROUS PLANTS are pretty easy to get into, but so far nobody has succeeded in getting to see the inside of a nonferrous one. We don't know why.

A COMPLETE ABSENCE OF PAPERWORK was noted in the metallurgical laboratories. There are practically no secretaries and no filing systems visible. Apparently the Russians do little letter writing and file filling, although they strongly believe in publishing books and pamphlets.

COMPANY PLANES are quite common in Russia, so an executive can quickly hop from one plant to another.

THE PLANT MANAGER is "god" in Russia. If the plant is in an isolated spot, he is likely to be boss of the whole area. In an effort to increase their own importance, they frequently build elaborate research facilities right in their own plants. In one bar products steel mill, a research group had been set up that seemed to have more people and equipment than the mill itself.

• Mostly about Education

RUSSIA'S 5-YEAR ENGINEERING GRADUATES are no better than graduates from our better engineering schools . . . and theirs start specializing long before ours do. Their general background is very meager.

THE FIRST TWO OR THREE YEARS AFTER GRADUATION must be spent at one's first job. After that, the engineering graduate can change jobs, or go back for postgraduate work, if he pleases.

IT'S ADVANTAGEOUS to graduate high in one's class, too, for the best students have the greatest choice from the jobs available. Those at the bottom of the class are apt to end up in some faroff spot in Siberia, if these are the only jobs left.

YOU ARE REWARDED if you do well, and punished if you do poorly. This applies to both students and workers. Thus, students, who are paid when they are going to school, lose their stipend if they fail once, and are expelled from school if they fail twice. Half of the steel mill worker's salary consists of a bonus. If he doesn't produce up to the norm, the bonus is cut. What's more, his base pay can actually be reduced if his performance is poor.

DOCTORS' DEGREES are always honorary in Russia — that is, the recipient doesn't do any direct school work for it. But few get them before they are 45.

Aluminum for Engine Parts?

Mercedes-Benz experience shows how widely this light metal can be used to reduce engine and vehicle weight, and speed production.

Based on paper by

Eberhard Hundt

Daimler-Benz, A.G.

THE aluminum piston is already a success and aluminum connecting rods are winning more attention. They are easier to design than steel ones, but attaching the bearing shells has been a problem. One solution has been to apply the bearing metal directly to the connecting rods without supporting shell. This has made the cost of the aluminum rod comparable to that of a steel one.

Light Weight Cylinder Heads

All Daimler-Benz passenger-car gasoline engines have aluminum heads. Cast iron is used on the small passenger-car diesels only because of cost. The changeover to aluminum permitted a rise in compression ratios with a resultant higher power output and lower fuel consumption.

Intake and exhaust valve seats have to be reinforced by rings. We used to make them of a special bronze, now we use a special cast iron. The seats are pressed in and fastened at the bottom. The walls must be strong and the ring not too low in order to keep them round and conduct the heat away easily. The inside shape is smooth to allow free flow of the gas. Troubles experienced with valve seats in aircraft engines have never developed with passenger-car engines.

Aluminum heads have a greater coefficient of expansion than cast-iron cylinder blocks, therefore, both dowel pins to the block cannot be solidly fastened on cylinder-in-line engines. This problem can be met by making the outer bolt holes into slots. To fasten the head to an aluminum block a self-cutting bushing is used, as shown in Fig. 1.

Corrosion may result when aluminum and steel come in contact with the cooling water. This happened when we made the cooling water nozzles of steel. Now the nozzle caps are made of aluminum and the trouble has been cured (Fig. 2).

Spark plugs are screwed into aluminum cylinder heads without bushings since there is sufficient material for later installation of a bushing, should a thread be damaged. The cylinder-head walls to the combustion chamber are relatively thick, which means all threads are correspondingly long.

Engine Block and Crankcase

Given an aluminum block, the first design question is whether to use wet or dry liners. In any case it is advantageous to have the cylinder head separated from the block at 90 deg to the center of the cylinder bore.

If a wet sleeve is used, the combustion chamber must not exceed the outer dimension of the sleeve lest it cause sealing troubles. If the block and/or housing is die-cast aluminum, only wet liners can be applied because undercuts cannot be used (Fig. 3).

Dry liners are easier to design, since a small collar at the upper end is sufficient to take care of a combustion chamber extension (The combustion chamber may extend the sleeve. And larger valves are possible, as shown in Fig. 3). The heat flow through the liner and cylinder wall to the cooling fluid is adequate.

Experiments with chrome-plated aluminum cylinder walls have been unsuccessful. The scrap losses were too high because of the probability of

Next Month . . .

. . . another article will be published on the coming aluminum engines. It will bring to light engineers' agreement on problems; divergence on solutions.

Yes!

defects in the chrome layer on one of the liners in a block of six, for instance.

Crankshaft bearings offer a problem with aluminum housings. When the engine warms up, the bearing clearance increases and lowers the oil pressure, with the result that connecting rod bearings receive insufficient lubrication. On the other hand, clearance cannot be too close or there may be squeezing at low temperatures. Applying bearing caps made of cast or tempered iron proved no solution and the only way out of the difficulty seems to be to use a big oil pump.

Miscellaneous Parts

When die casting can be used, aluminum parts are recommended even for replacement of steel sheet. Die-cast aluminum oil pans have been successful. Electrolytically produced aluminum has proved satisfactory for cylinder head covers. Other parts such as fans, water pump housings, oil pump housings (upper and lower), oil filter housings, oil intake, and camshaft bearing supports can be made of light metal. Die-cast aluminum saves manufacturing time. Our practice is to shot blast all cast aluminum parts with aluminum shot so they will stay clean. Steel shot causes a reddish corrosion to appear on the surface.

At Daimler-Benz we are also using aluminum for body cross members.

Principles of Aluminum Use

The difference in basic characteristics between aluminum and steel must be considered carefully when changing over to aluminum for mass production of parts. Moreover, the right alloy must be selected for the particular part. Broadly speaking, when a part is to be subjected to high mechanical or thermal stress, high-quality cast aluminum alloys or, in special instances, forgeable aluminum alloy can be chosen. For cylinder heads with complex forms of the inner cooling space, with inside guides for the cooling fluid, or on aircooled engines with cooling fins, heat-treatable aluminum alloys with high silicon content "silumin gamma" may be used. The aluminum-silicon alloys can also be used for crankcases, which can be die cast when production figures are within a reasonable range.

For parts under low stress, magnesium alloys can be used, but not for parts subjected to the salt of winterized roads, which would cause corrosion.

To Order Paper No. 68B . . .
. . . on which this article is based, turn to page 6.

Ratios of Aluminum to Iron or Steel

Weight	1 to 3 (actually 1 to 2 due to thicker walls)
Thermal conductivity	3 to 1
Expansion	3 to 1
Cutting speed in machining	5 to 1
(Correct measurements in die casting and permanent mold casting down to 0.002 in.)	
Prices (in Germany)	4 to 1

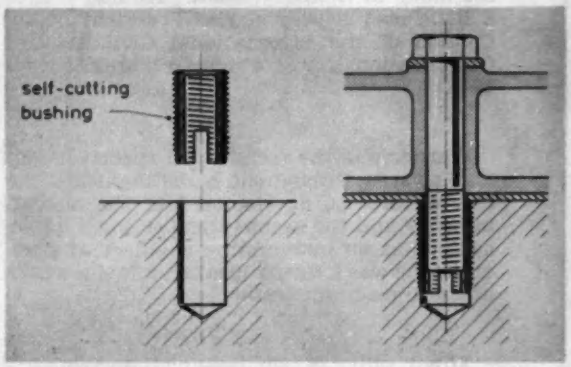


Fig. 1 — Cylinder-head-to-block mounting showing use of self-cutting bushing.

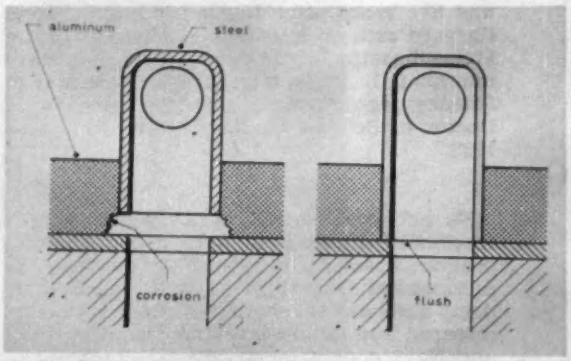


Fig. 2 — Corrosion of water jacket (left) caused by aluminum and steel coming in contact with cooling water was cured (right) by making the nozzle caps of aluminum and setting them flush.

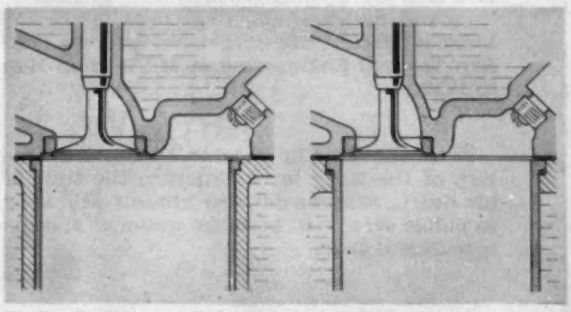


Fig. 3 — Dry and wet cylinder sleeves receive different treatment when using an aluminum block. With the dry sleeve (left) the combustion chamber can exceed the outer dimension of the sleeve, permitting a larger valve to be used than with the wet sleeve (right).

Dr. Edward P. Warner

DR. EDWARD P. WARNER, president of SAE in 1930 at the age of 36, died on July 11 at his home in Duxbury, Mass. He had retired a little over a year ago as President of the Council of the International Civil Aviation Organization, a post which he had held since 1945.

Warner was the recipient of special honors and awards throughout a distinguished career devoted to development of the aircraft industry and the aeronautical sciences. Recognized as an outstanding engineer and scientist, he was a fluent speaker, a facile writer, and a fine administrator.

When only 16, he designed and built a glider which competed successfully in the first intercollegiate glider meet in 1911. This was five years prior to his graduation from Harvard with an A.B. degree; six years before Massachusetts Institute of Technology gave him his B.S. In 1919, he earned his Master of Science degree from M.I.T. He was made a Doctor of Science by Norwich University in 1938.

He achieved stature as a scientist and a teacher in the years between college and his post as Assistant Secretary of the Navy for Aeronautics from 1926 to 1929. As a U. S. Army aeronautical engineer he had conducted research and taught airplane design in Army and Navy courses at M.I.T. As chief physicist, National Advisory Committee for Aeronautics, he had inaugurated aerodynamics and free flight research in that organization . . . and designed the first wind tunnel at Langley Field. He had been professor of Aeronautical Engineering at M.I.T. from 1920 to 1926.

From the time he became Assistant Secretary of the Navy for Aviation to the time of his death, Warner devoted himself primarily to public service in both the national and international field.

Following five years as editor of McGraw-Hill's "Aviation," he served as vice-chairman of the Federal Aviation Commission, in 1934–35; as economic and technical advisor to the Civil Aeronautics Authority in 1939; and, shortly thereafter, as a member of the Civil Aeronautics Board. He served also as a special assistant to Hon. Dwight W. Morrow in connection with the work of the President's Aircraft Board in 1925.

Two years after he served as SAE President, he won the Society's Wright Brothers Medal. In 1949, he received the Daniel S. Guggenheim Medal . . . and in 1957 his work won him the Wright Brothers Memorial Trophy "for significant public service of enduring value to aviation in the United States." (Presentation of this latter award was made by Vice-President Richard S. Nixon.)

Warner's services to SAE were myriad. He had served as chairman of the Publication Committee; of the aeronautic division of the Standards Committee; of the Wright Brothers Medal Committee; of the Constitution Committee; of the Overseas Relations Committee; of the Student Committee . . . and as a member of many other technical and administrative SAE groups.

"To all who had the privilege of knowing him," says a posthumous tribute from the ICAO Council, "he imparted his knowledge, his equanimity, his international spirit. In his personal contacts, he always gave warm friendship and kindness, which were particularly impressive because they came from an outstanding man, yet were wrapped in modesty."

Within a few years before his death, Warner also received the Flight Safety Foundation Award and an award of Commander of the Order of the Crown from Belgium.

Surviving are his wife, Joan Potter Warner; a son, Barry Warner; a daughter, Sandra Warner; and two brothers, Robert Warner and Dr. Nathaniel Warner.

Dr. Edward P. Warner

1894–1958

If the designer matches materials with type of design and uses insulating metals or ceramics . . .

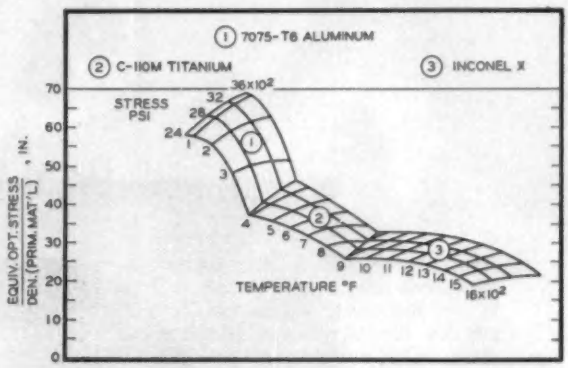


Fig. 1 — Best material for multiweb, sheet-skin beams varies with applied stress and temperature. The plot is a partial envelope of optimum stress.

2000 F Structures Are Possible Now

Based on paper by

Harry A. Pearl

Bell Aircraft Corp.

TO GET the best high-temperature structural designs, the engineer must examine simultaneously the materials to be used and the type of design, including thermal insulation barriers or cooling systems. An integrated selection is necessary because of wide variations in metal strength at elevated temperatures. In the case of cooled structures, the engineer will find that two or more metals may be teamed to give the most efficient structure.

An example of these facts is the multiweb beam with a sheet skin. The most efficient structure for low temperatures makes use of aluminum. As the temperature requirement rises to the 400–800 F range, titanium is the best material, and above 900 F Inconel X takes over. Fig. 1 shows this relation plotted against an efficiency factor (equivalent optimum stress/density of primary material). The dimensions of the factor are inches and the larger the number the more efficient the structure. The stress applied to the structure forms a cross-plot with temperature of the whole structure.

An extension of the example is the choice between a sandwich or sheet-type skin for the multi-web beam. Adding this design possibility shows that sandwich skins are more efficient on lightly stressed structures. (See Fig. 2) In each of these cases the cross-plot is only shown for the most efficient material at a given temperature and stress.

Fig. 3 shows when to cool the structure. The dark area is for multiweb structures kept at 200 F. With this cooling, aluminum is more efficient than uncooled Inconel X except for a very lightly loaded structure. This indicates high-temperature materials should be used for low stress or protective applications.

What Materials Are Available?

The loss in strength of "high temperature" alloys is a combination of oxidation and microstructure change. Test results given in Fig. 4 place the major drop in tensile strength to the changing microstructure. Metals with a recrystallization temperature above design temperature are needed. If 2000 F performance is needed, then molybdenum, columbium, rhenium, tungsten, or tantalum should be used.

An alternate solution is to go to ceramics for the outer, lightly loaded skin. Aluminum oxide tensile strength compares favorably with that of many

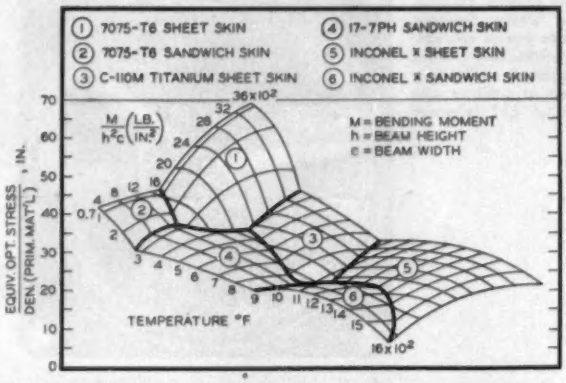

1 7075-T6 SHEET SKIN
2 7075-T6 SANDWICH SKIN
3 C-110M TITANIUM SHEET SKIN
4 17-7PH SANDWICH SKIN
5 INCONEL X SHEET SKIN
6 INCONEL X SANDWICH SKIN
M = BENDING MOMENT
h = BEAM HEIGHT
c = BEAM WIDTH
EQUIV. OPT. STRESS / DEN. (PRIM. MAT'L), IN.
TEMPERATURE °F

Fig. 2 — Sandwich skin on multiweb beam shows improvement in efficiency over sheet skin for low-stress applications. Graphs of other design configurations, such as cylinders, would call for different materials at the same stresses and temperatures.

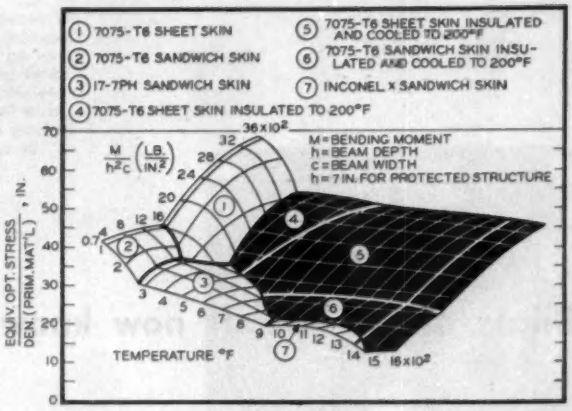

1 7075-T6 SHEET SKIN
2 7075-T6 SANDWICH SKIN
3 17-7PH SANDWICH SKIN
4 7075-T6 SHEET SKIN INSULATED TO 200°F
5 7075-T6 SHEET SKIN INSULATED AND COOLED TO 200°F
6 7075-T6 SANDWICH SKIN INSULATED AND COOLED TO 200°F
7 INCONEL X SANDWICH SKIN
M = BENDING MOMENT
h = BEAM DEPTH
c = BEAM WIDTH
h = 7 IN. FOR PROTECTED STRUCTURE
EQUIV. OPT. STRESS / DEN. (PRIM. MAT'L), IN.
TEMPERATURE °F

Fig. 3 — Cooling the structure increases its efficiency at high temperatures and changes the choice of the material used. The efficiency, stress/density is for insulations that will hold the 200 F inside temperature for 1 hr.

metals at temperatures of 2000 F or better. For example:

Temperature, F	Aluminum Oxide Tensile Strength, psi	Unalloyed Molybdenum Tensile Strength, psi
70	38,000	100,000
570	36,000	85,000
1470	34,000	63,000
1830	—	40,000
2010	—	35,000
2070	31,000	30,000

Not only does the strength of ceramics stay nearly unchanged in the temperature range considered but the oxidation problems are minor compared to metals.

Microwave transmission for radar through ceramics is excellent. In fact, aluminum oxide up to 1800 F is a better transmitter than the material used in many radomes today at room temperature.

Despite ceramics' brittleness and low mechanical impact strength, it still offers the designer a top material for high-temperature compression loaded structures which are typical of missiles and aircraft.

To Order Paper No. 46B . . .
. . . on which this article is based, turn to page 6.

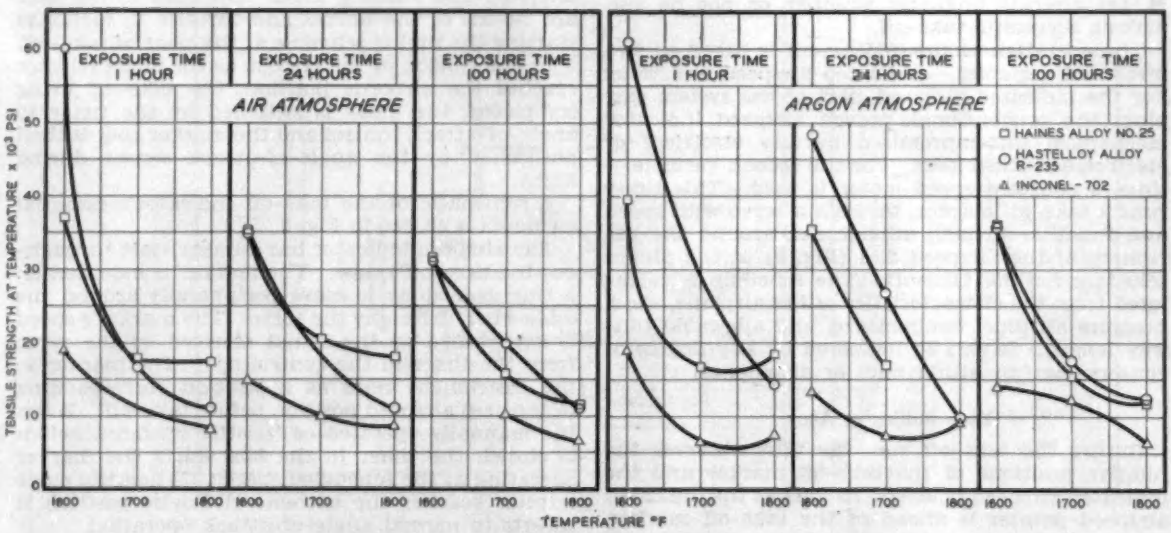


Fig. 4 — Strength of several high-temperature alloys tested at elevated temperatures shows that the major loss of tensile strength is caused by microstructure change. By testing in air and argon, the effects of oxidation are exposed. Even the oxidation effects can be serious if very thin sheets of these materials are used for the skin of missiles or aircraft.

Pilots of jet aircraft now know

whether or not they can make

a successful takeoff because . . .

New Instrument Indicates

Based on paper by

Jack Andresen and E. H. Schroeder

Kollsman Instrument Corp.

A NEW Kollsman instrument tells the pilot of a jet aircraft promptly whether or not he can make a successful take-off.

The operation of the instrument is based on two measured variables — indicated airspeed and time. For the indicated airspeed, part of the system employs the conventional, proved airspeed indicator mechanism uncompromised by any electrical or electromechanical gear. For the second variable — time, a constant-speed motor is used. This timer runs a take-off marker, through a servo with speed and function-shaping adjustment, around the periphery of the airspeed dial (Fig. 1) at the proper schedule for the take-off. The schedule is calculated from the characteristics of the airplane, wind, pressure altitude, temperature, and allowable runway length. It can be tempered by any degree of conservatism by either pilot or dispatcher.

Keep Rolling or Abort

During the take-off run, the pilot observes the relative positions of the take-off marker and the indicated airspeed pointer. As long as the indicated airspeed pointer is ahead of the take-off marker, all is well, but if at any time during the take-off run the marker catches up to the airspeed pointer, the take-off should be aborted.

A control box (Fig. 2), located convenient to the pilot, contains the timing motor, a speed-changing mechanism, a transmitting synchro, and the mode switch. On the box face is located the rate of IAS adjustment knob as well as a zero setting (mode selector) and starting knob. Optional to the user are tie-ins to the brakes and throttle to facilitate starting the timing schedule at the start of take-off.

In one version of the system, as the mode selector reaches the airborne position, the take-off being completed, the mode is switched by the timer to angle-of-attack control and the marker ring is then positioned by the angle-of-attack sensor during flight.

A schematic of the take-off indicator's essential elements is shown in Fig. 3.

The airspeed indicator has a linear scale throughout the take-off range. The marker is mounted on a ring gear so as to move peripherally around the scale when driven by the servo. The marker's speed is determined by the signal received by the servo from the timer in the control box. The marker in the instrument rests at a position corresponding to the zero airspeed position before take-off. When the manually operated or throttle operated switch is closed, the timer in the box starts the marker operating at the scheduled speeds. When the mode selector reaches the extreme clockwise position it reverts to normal angle-of-attack operation.

To Order Paper No. 38C . . .
. . . on which this article is based, turn to page 6.

Fig. 1 — Relative positions of take-off marker and indicated airspeed pointer tell jet pilot whether or not existing thrust, applied over entire usable runway length, is sufficient to enable airplane to reach required minimum IAS for take-off.

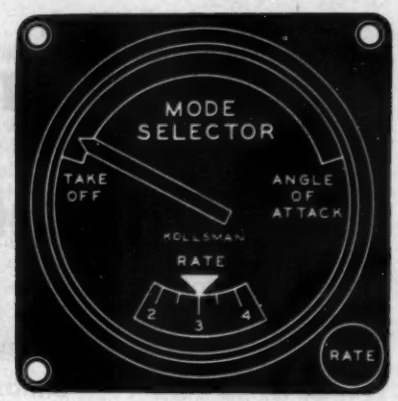


Fig. 2 — Control box of Kollsman take-off indicator contains timing motor, speed-changing mechanism, transmitting synchro, and mode switch, handy to pilot.

Take-Off Progress

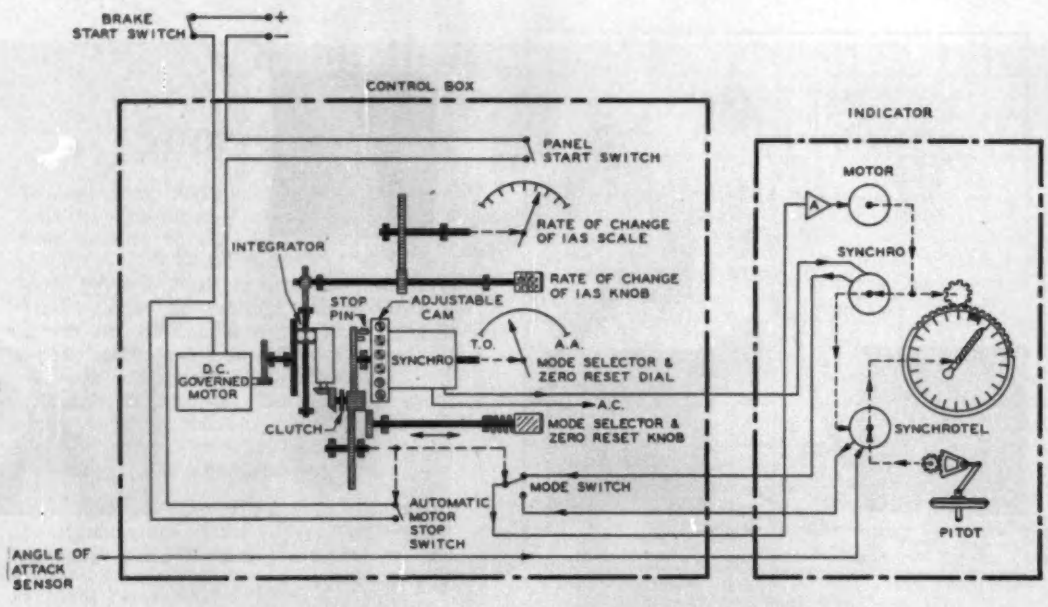


Fig. 3 — Schematic of essential elements of Kollsman take-off indicator.

Zirconia and Alumina Coatings Give Short-Time 3000 F Steel Protection

Cermet, refractory oxide, and aluminum coatings protect almost all metals against high temperatures and provide surface properties tailored to the application.

Based on paper by

John V. Long
Solar Aircraft Co.

BOOSTING the high-temperature performance of steel is one of the main functions of cermet or oxide coatings, but they are also used for antigalling, radiant heat control, and protection of noncritical materials. Three current coating techniques are flame spraying refractory oxides, diffusing aluminum into the surface, and baking on cermet coatings.

3000 F Protection Using Oxides

Flame spraying of powdered refractory oxides, studies show, gives over 3000 F protection for short periods of time. This type of coating might be used for missile re-entry cones.

Aluminum and zirconium oxides are refractory

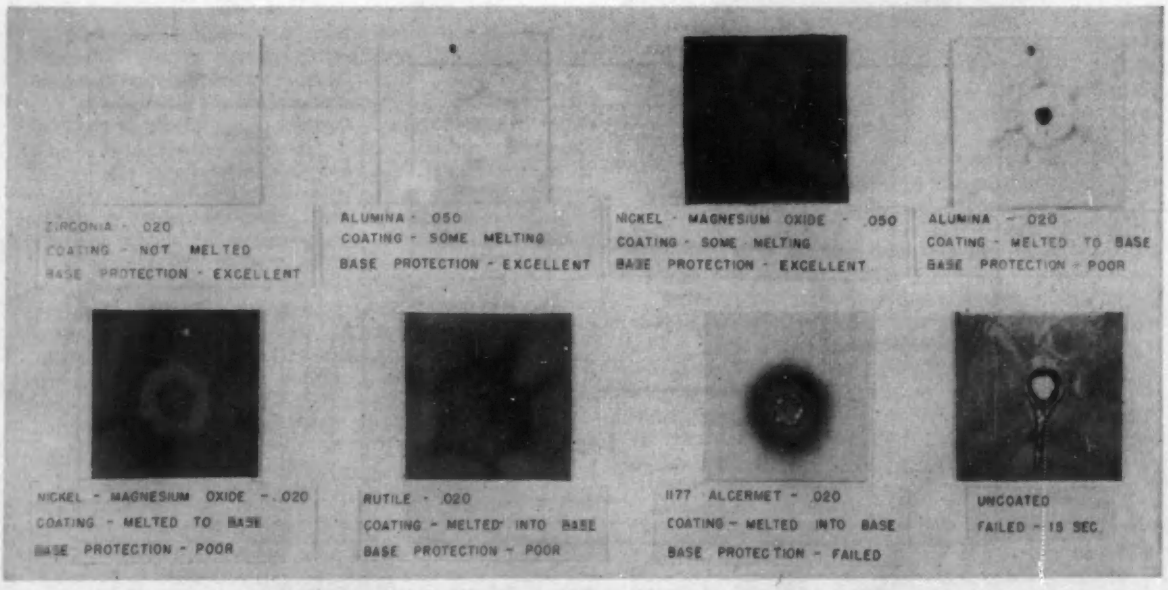

ZIRCONIA - .020
COATING - NOT MELTED
BASE PROTECTION - EXCELLENT
ALUMINA - .050
COATING - SOME MELTING
BASE PROTECTION - EXCELLENT
NICKEL - MAGNESIUM OXIDE - .050
COATING - SOME MELTING
BASE PROTECTION - EXCELLENT
ALUMINA - .020
COATING - MELTED TO BASE
BASE PROTECTION - POOR
NICKEL - MAGNESIUM OXIDE - .020
COATING - MELTED TO BASE
BASE PROTECTION - POOR
RUTILE - .020
COATING - MELTED INTO BASE
BASE PROTECTION - POOR
1177 ALCERMET - .020
COATING - MELTED INTO BASE
BASE PROTECTION - FAILED
UNCOATED
FAILED - 15 SEC.

Fig. 1 — Flame sprayed steel, SAE 1010, shows zirconia as a good high-temperature coating. Each 0.125-in. thick plate was burnt with an oxyacetylene flame for 20 sec. Theoretical flame temperature was 5680 F. Protection at this temperature would not be practical with cermet, ceramic, or metal coatings.

materials that have received the most attention, but the flame spraying operation can be used for a wide variety of coatings on different base metals. An example of the protection offered to a regular SAE 1010 steel by seven different coatings is shown in Fig. 1.

Complex Part Protection Using Aluminum

Aluminum has been used for corrosion and oxidation protection for many years. However, applying the coating with a cermet flux produces a diffused aluminum coating on practically any part fabricated of carbon steel, stainless steel, superalloys, or titanium. Previous coating techniques were confined to relatively simple parts.

A ceramic flux is mixed with powdered aluminum to form a mixture called the slip. The part is then dipped or sprayed with the slip, allowed to dry, and fired in an oven. The aluminum deposits on and diffuses into the base metal while the flux remains on the top as a protective layer. The flux is later washed off. Firing is at 1650–2100 F, depending on the base metal.

Another way of diffusing the aluminum is to deposit it under a ceramic flux as before, then diffuse it in a later heat-treating operation. Initial firing temperatures for this method range from 1250 to 1450 F.

Some results of aluminum protection against oxidation are:

Stainless Steel (321)	2100 F for 50 hr
Inconel X	2150 F for 100 hr
Haynes Stellite 25 (L605)	2400 F for 10 hr
Carbon Steel	1500 F for 2000 hr

Diversified Use of Coatings

The aluminum diffusion coating technique is just one use of cermets. Mixing ceramics and metals gives the metallurgist an opportunity to tailor the coating to the application.

By mixing molysulfide or graphite into the ceramic, a low-friction surface is produced to combat galling and fretting at elevated temperatures. Coefficients of friction as low as 0.125 have been measured. Applications range from reciprocating engine ball joints to afterburner actuating rods and thin wall ducting slip joints. Low-friction coatings can be made for temperatures up to 1700 F.

Reflective or emissive coatings can be mixed of ceramic materials to control radiant heat. A specific application is a brazed honeycomb afterburner shroud that has a reflective coating on the inside and an emissive coating on the outside to reduce the steady-state temperature.

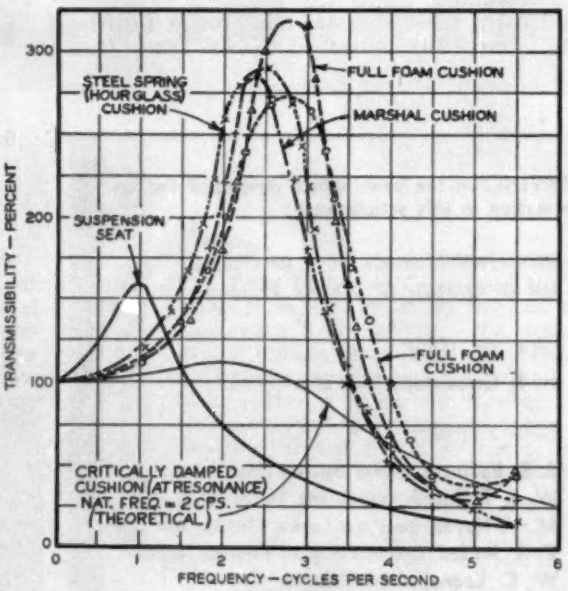
To Order Paper No. 46C . . .
. . . on which this article is based, turn to page 6.

Damp the Seat Cushions

Typical seat cushions of today have a natural frequency under the driver's weight close to that of commercial vehicles on their suspensions (2.5 to 3 cps). Most seats have little internal damping. This means the cushion can produce a driver ride which is worse than sitting on a hard seat. A critically damped cushion would avoid this effect.

A suspension seat can also be used. However, the relative motion between the driver and the truck controls can be excessive with this arrangement.

(The curve showing critically damped cushion at resonance in the accompanying chart was incorrectly plotted when used in the June SAE Journal on page 72 as part of the article on Eight Points for Improving Car Ride.)



Switch to Numerical Control Can Be Easy

Based on secretary's report by

H. P. Grossimon, Concord Control, Inc.

SWITCHING to numerical control shouldn't be too difficult because:

1. The same skills are needed for numerical controls as for conventional methods.
2. Numerically controlled machines are quite compatible with conventional machines — a switch from one to the other will neither be sudden nor complete.

Because numerical control is so new, however, an employer often must train operating and maintenance personnel. Maintenance of positioning systems can be learned in a week or two. Learning to maintain contouring systems takes a little longer.

Maintenance records so far are very encouraging on the 25 controlled contouring machines now used by aircraft builders. First used in 1957, these machines have from three to five fixed axes of continuous control. But despite their complexity, good maintenance records have been produced by newly trained personnel.

In addition, these builders have found that installing numerically controlled tools is easier than getting template-controlled machines on the line. This means that numerically controlled tools get into production sooner.

Cost of a numerical control system isn't prohibitive if the following considerations are kept in mind:

1. Total capital investment for manufacturing and supporting equipment. Individual machines tend to cost more when numerically controlled, but less supporting equipment is needed.
2. Personnel factors. Personnel must be trained to program for, operate, and maintain numerically controlled tools. More skills are needed in data processing and tooling; less at the machine itself.
3. Data processing and tooling. Programming costs money. But tooling costs tend to be less. Fewer fixtures are needed. And templates are eliminated.
4. Manufacturing inventory costs. Numerical control reduces lead times, reduces parts in process, and eliminates storage of masters or models.
5. Production planning and scheduling. Part changes are easier with numerical control. Model changeovers are quicker. Inspection times are shorter.
6. Production area requirements. For short and medium run production, where numerical control is best applied, less production area is needed to make the same number of parts per hour.

Programming for the average milled part is easy too. And programming for positioning applications is easier yet. True, programming for the milling of complex aircraft parts is a complex job. But, usually, the details of programming for this type of work are handled by computers. So programming costs per part are low.

Bright Future for Numerical Control

New positioning systems, automatic turret lathes, and new applications for contouring systems are some of the things in the future for numerical control. Typical applications may include:

1. Positioning systems for drilling condenser tube sheets. These machines will position at very high speeds. Other positioning systems will compromise positioning speed for higher ac-

SERVING on the panel which developed the information in this article were:

panel leader:

W. M. Stocker, Jr., American Machinist

panel secretary:

H. P. Grossimon, Concord Control, Inc.

panel members:

J. R. Ballinger, Bendix Aviation Corp.
W. E. Brainard, Kearney and Trecker Corp.
M. V. Hayes, Jones and Lamson Machine Tool Co.
K. S. Jensen, Gliddings & Lewis Machine Tool Co.
W. C. Leone, Hughes Products
W. M. Webster, Air Materiel Command

uracies — 0.0001–0.0002 in. will be typical.

2. Completely automatic turret lathes which will incorporate tool positioning and automatic selection of tools, feed rates, and cutting speeds.
3. Three-dimensional contouring systems for die sinking.

Passenger-car body dies are another possible application for numerical control. Controlled from tapes prepared by computers, this application will eliminate problems caused by the growing shortage of skilled die sinkers, will reduce machining errors, and will improve surface finishes. Thus better dies will be made more quickly and less hand finishing will be required. In addition, shrink allowances can be taken into account automatically by the computer in the preparation of the input tape.

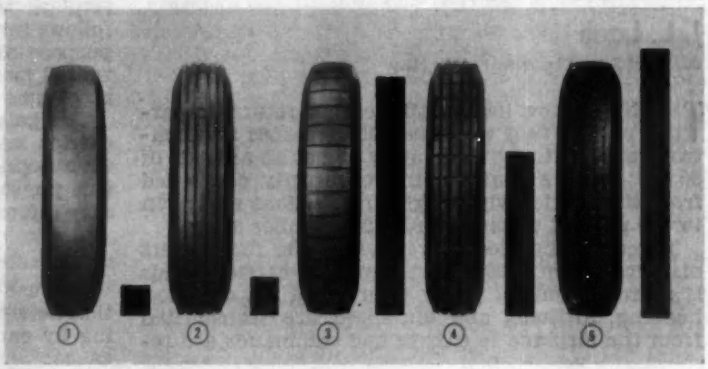
Numerically controlled transfer machines are another possibility for passenger-car application. They would permit more rapid model changeovers and would enable the manufacturer to shift manufacturing assignments quickly during uncertain or rapidly changing economic periods.

To Order Paper No. SP-322 . . .
. . . on which this article is based, turn to page 6.

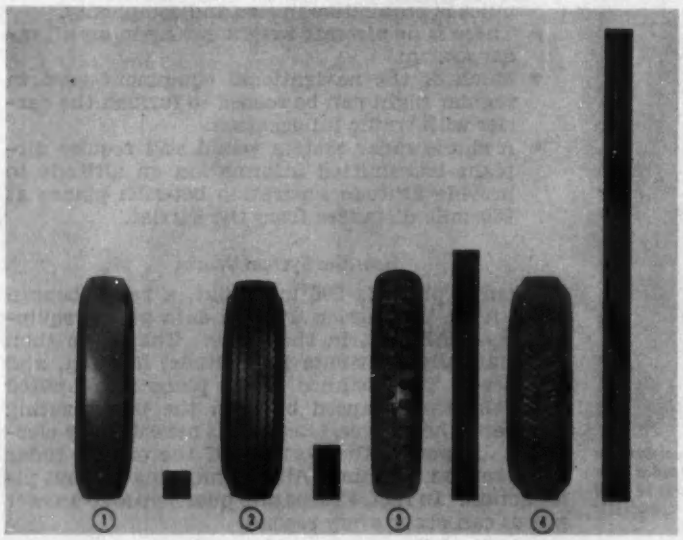
Truck Tire Study . . .

. . . reveals fundamental principles of relationship between tread design and tire noise. Conventional rib type found to present no problems.

Based on paper by **T. A. Robertson and J. H. Cox,** Firestone Tire & Rubber Co.



Comparative Noise Levels of Elementary Truck Tire Tread Designs — Vertical bars show noise levels expressed in phons. Straight circumferential grooves (2) add little to the noise level of the perfectly smooth basic tire (1). Worst offenders are the bar type tread (3), used for some off-the-road and traction type truck tires, and the tread design employing uniformly spaced pockets (5). The pockets create a suction cup effect and produce an unpleasant high-pitched whine. The combination of cross grooves and circumferential ribs (4) makes quite a loud, pounding noise.



Comparative Noise Levels of Various Truck Tire Tread Designs in Commercial Use — These correspond closely to those of the elementary tread designs. The regular five-rib highway tread design (2) is only a little noisier than the basic, plain tire (1). Noise levels rise sharply with the cross-bar type represented by the nondirectional military tire (3), and even more sharply with the traction-type recap, which has large pockets in the tread design (4).

To Order Paper No. 56B . . .
on which this article is based, turn to page 6.

Navy Planes Can Land in All Weather

. . . with the new 3 zone control system

Based on paper by

A. B. Winick,
Bureau of Aeronautics, Department of the Navy

J. L. Loeb
Bureau of Ships, Department of the Navy

THE NAVY now has an all-weather return-to-carrier system that will land 100 airplanes and control traffic up to 200 miles away and at an altitude of 80,000 feet. Actual landing is directly controlled from the carrier while flight instructions are given to the pilot at distances from 2–200 miles away.

Three distinct zones are used. The first covers distances from 8–200 miles from the carrier. This is a traffic control phase where bearing, distance, heading, altitude, and air speed are transmitted from the airplane to carrier and commands are returned to direct pilot action. In Fig. 1 the programing equipment of this phase is called SPA-13.

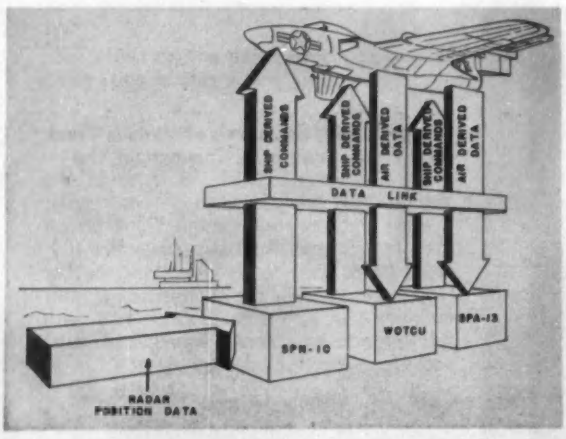


Fig. 1 — Three systems are used to bring Navy planes to touchdown in all-weather operations. SPA-13 covers operations from 8-200 miles from the carrier, WOTCU operates 2-8 miles from the carrier, and SPN-10 brings the plane in to touchdown. Only the last phase is completely controlled by carrier-based radar.

The second zone is 2–8 miles from the carrier. This area is for transition and wave-off. Again the airplane transmits flight information and the pilot follows instructions received from the carrier. The purpose of this zone is to bring the airplane to a "gate" two miles from the carrier at exactly the right time and position. (See WOTCU in Fig. 1.)

The gate is the start of the third zone where the carrier takes over control of the airplane through its autopilot and brings it in for the landing. In this phase (SPN-10) the carrier obtains all necessary information from its own tracking radar.

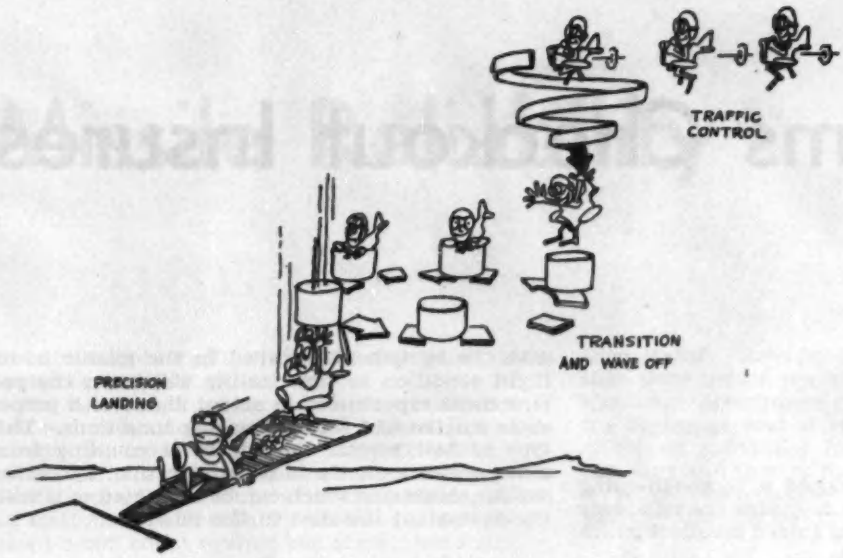
Why a Split System?

The use of two systems (interchange of information between carrier and airplane, and direct tracking by carrier-based radar) was decided upon because:

- Shipborne radar to track 100 airplanes at 200 miles is prohibitive in size and complexity.
- There is no aircraft weight saving in an all radar system.
- Much of the navigational equipment used in regular flight can be reused to furnish the carrier with traffic information.
- A single radar system would still require airplane-transmitted information on altitude to provide altitude separation between planes at 200-mile distances from the carrier.

How the System Works

When a plane is 200 miles out, a radar beacon pulse from the carrier triggers data giving equipment, AN/ARN-26, in the plane. The plane then automatically transmits its altitude, heading, and air speed. The distance to the plane is computed from the time elapsed between the interrogating pulse and the answer. Bearing is measured by electronically noting the position of the carrier radar pulse beacon antenna. All this happens without pilot action. In fact, 45 separate question-and-answer pulses can occur every second.



The equipment on the carrier, AN/ARN-26, then computes the best course for the approaching plane and sends this back to the pilot. This information shows up on a display board in the cockpit as a command for correct altitude, heading, bearing, distance, air speed, and one of 31 "canned" orders. The pilot may select anyone of 31 canned replies to be transmitted to the ship.

There are 126 channels available and the ship pulses its airplanes in roll-call fashion. It can contact the 100 planes in under three seconds. The rate of contacting any particular plane depends on its position. Planes close by may be contacted 10 times a second, while those far away would be pulsed only once every six seconds.

The same system is used in the transition range of 2–8 miles. Here pilots are instructed to fly in precise patterns leading to the gate shown in Fig. 2. The method of control is the same as in the first zone. Only the data link, WOTCU, is different. It is in this zone that planes re-enter the pattern after a wave-off.

At the two-mile gate a K-band fire-control-type radar is used to track the aircraft precisely. A small corner reflector attached to the nose wheel reduces the effects of scintillation and cuts tracking errors to one foot at the touchdown area. A carrier analog computer calculates the flight path and signals are sent to the autopilot of the airplane. These signals change the pitch and bank of the plane to keep it to the predetermined path. Aircraft powerplant controls are coupled in with pitch controls to reduce the sensitivity-to-speed of pitch commands.

Corrections for carrier roll, yaw, and pitch are fed into the computer to compensate for the unstable base of the tracking radar.

Tight autopilot control is required to provide for the lateral and longitudinal dispersion of the flight deck, which is ±10 ft and ±20 ft, respectively, 95% of the time. To match this the autopilot control of pitch and bank is 0.1 and 0.2 deg, respectively.

To Order Paper No. 43A . . .
. . . on which this article is based, turn to page 6.

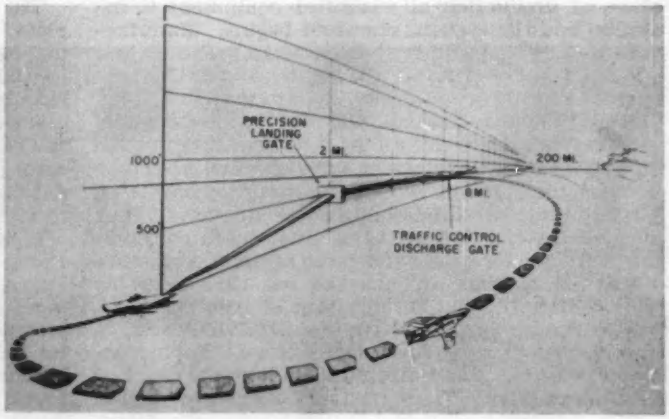


Fig. 2 — The first two zones of control bring the plane to a spot two miles behind and 500 ft above the carrier. From here on the plane is completely controlled through its autopilot by the carrier.

Systems Checkout Insures

Based on paper by

M. A. Stephens
Chance Vought Aircraft, Inc.

CHANCE Vought has developed a thorough-going production-test program to insure the reliability of the systems of the Regulus guided missile it builds for the Navy.

Testing and checking the missile in the shop fabrication stages is of a type to assure proper installation of wiring, tubing, and components — and is more in the nature of a quality control than a performance test.

Shop testing of electrical continuity is performed with a circuit continuity checker called a "pin-ball machine" designed and built by the company. This device is so designed as to permit complete checkout of harnesses for continuity and proper connection after installation in the missile. High potential testing of all missile harnesses is also performed. Automatic circuit analyzers have not been used on Chance Vought missiles up to now, mainly because high resistance shorts and other hard-to-find circuit discrepancies are at a minimum and the small occurrence rate does not justify the expense.

The wing fold system and landing gear systems are checked out in the shop using a wing fold test unit, a landing gear cycling unit, and external power.

first steps in the checkout

When missiles are shop complete they are moved to the missile installation and test unit. At this stage of production all classified equipment is installed and the systems checkout begins. Manufacturing and inspection personnel do the actual checking-out, verifying the system within limits specified by the engineering department.

Each system is checked out as being a complete, integrated system and also in conjunction with other dependent systems. Such checkouts include a functional test of pneumatic systems, operating landing gear, parabrake and slipper ejection. These systems are checked by themselves and in conjunction with the electrical and radio command systems. Hydraulic systems are checked out thoroughly as a unit, then, during stabilization system checkout, the hydraulic portion of the stabilization system is checked again as part of that system. Each electronic, electrical, and mechanical system is checked in this manner. These systems checks are made with the equipment installed in the missile in its flight condition so that testing will be in the environment experienced in actual flight, with proper cable lengths and flight mounting conditions. This type of test reveals the effects of coupling from other systems, engine induced vibration, and other similar conditions which can be evaluated only with the equipment installed in the missile.

checking for flight readiness

After systems checks are completed and all systems are operating within specification limits, the missile is put into an acceptance status. Flight readiness is determined by the following procedure.

All discrepancies are reworked or otherwise accounted for, and when company and Navy inspection finds all satisfactory, the missile is transferred to the ramp. Here four missiles can be tested simultaneously. Umbilical and checkout cables are carried in built-in raceways from the control room to the test cell where they are dropped from the overhead to the missile. In the control room are start and launch, radio command, and various checkout consoles. The consoles used in this ramp checkout are like those found in shipboard and mobile installations for operational use. A suitable intercommunication system is provided between ramp and console. A telemeter van is part of the equipment. Although designed primarily for flight test use, it serves a useful function in final acceptance of missiles.

qualifications for acceptance

The acceptance run actually is a series of complete, simulated flights conducted by manufacturing personnel and observed by the inspection department. Normal start and launch procedures are followed, rocket and slipper ejection is accomplished, a simulated flight pattern is flown and, in the case of a fleet training missile, a simulated recovery is made with landing gear extension and parabrake deployment. A suitable terminal maneuver is used with a tactical missile.

A company inspector keeps records of malfunctions, time, and notes during a simulated flight. From these flights an acceptance index is determined which can be defined as the number of completed simulated flights divided by the cumulative malfunctions. The duration of the flight is not used in the acceptance index calculation, since it was found that there was a tendency to let a missile run

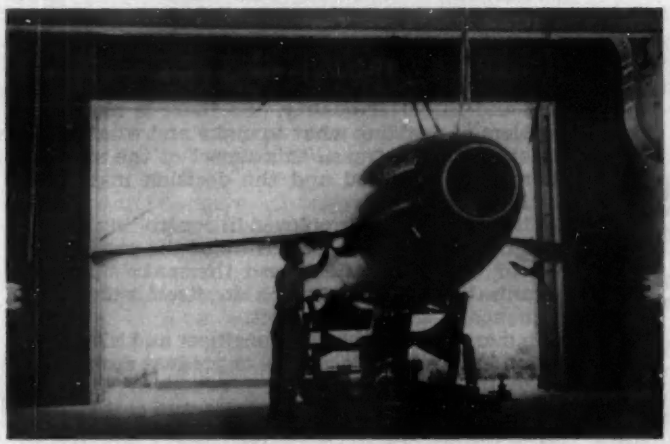
Missile Reliability

and accumulate malfunction-free time when it was operating properly on the ramp.

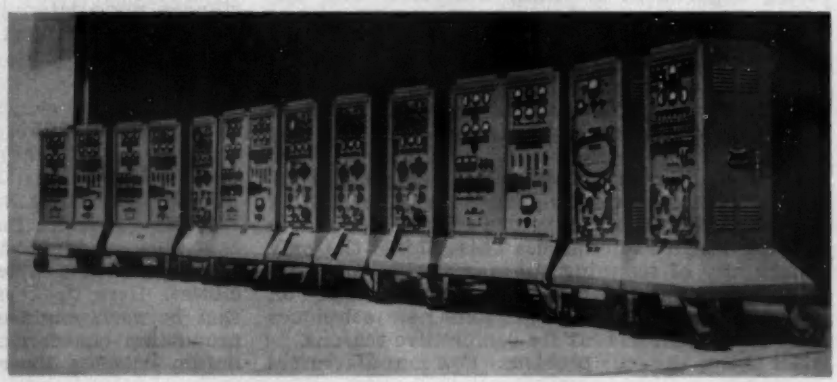
The acceptance requirements are a minimum of five complete, simulated flights with a minimum acceptance index of 1.2 and all malfunctions resolved. If a malfunction forces a shut down, the partial run will not count as a simulated flight, but all malfunctions in both the partial run and subsequent rerun count against the acceptance index.

If a missile completes five flights and the acceptance index is less than 0.5, the missile reverts to shop status. Rework, retest, and setup runs are then done before the missile is resubmitted to inspection. Acceptance runs are then started from the beginning and after successful completion the missile is submitted for final inspection, first to company and then to Navy inspectors. With all remaining discrepancies resolved, the missile is painted and marked for delivery.

To Order Paper No. 48B . . .
. . . on which this article is based, turn to page 6.



A MISSILE in one of the test cells on the test ramps at Chance Vought Aircraft. Facilities permit four missiles to be tested simultaneously.



HANGAR CHECKOUT EQUIPMENT in a typical line-up. Identical equipment is going to the Services for operational use, with the result that missile quality is better and service problems have been reduced. Equipment designed to check out a specific system in a specific missile involves such items as an airspeed-altitude simulator to match the missile profile, a servo analyzer for checking the stabilization system, and a means for checking the firing circuits. It has two important advantages — it does a better job of checking and the technical level required of operators is lower.

COMMUNICATION —Key to Company Survival

Here's how Chevrolet, Cummins Engine, Thompson Products, Dana, Clark Equipment, and International Harvester organize for coordination of engineering and manufacturing.

Based on secretary's report by

Joseph Geschelin
Chilton Publications

PROPER COORDINATION of engineering and manufacturing represents one of the most important problems in the automotive manufacturing industries. Communication between these functions has a vital bearing on the ability of an organization to compete on the basis of cost as well as product performance.

While engineering is concerned primarily with advance product planning, the manufacturing department must be aware of new processes and new techniques since these affect cost, and productivity, and quality. In short, communication is mandatory if an organization is to survive in a highly competitive industry.

Besides worrying about prime costs, the manufacturing department is vitally concerned with the maximum utilization of its existing facilities. And its first concern is to make sure that many, if not all, of the parts of a new product can be manufactured with existing facilities. On the other hand, this group constantly seeks new methods and new equipment since these are instrumental in reducing costs.

Consequently, communication between engineering and manufacturing implies the need for getting manufacturing into the picture at the stage before product design is finalized. This affords the only opportunity of scanning the new design to determine whether it can be produced economically on existing equipment or whether some new techniques must be brought to bear for competitive reasons.

Nor is this the only problem. Few manufacturers attempt to make every component in their own plants. Frequently certain specialized parts and elements are obtainable from parts makers at lower cost and in better quality. So there is always the problem of deciding what to make and what to buy. Before design is frozen this aspect of the matter is thoroughly analyzed and the decision made early in the game.

The method to be employed in controlling product design depends upon the nature of the product, the size of the organization, and the make up of the organizational chart, which in itself reflects the influence of size and product.

In many plants, the chief engineer and his organization have complete control of product design right up to the point of starting production. It is also noteworthy that purchasing, sales, and cost estimating have been given a vital role in all deliberations from the development of a new idea to its translation into manufacturing.

Too, every alert organization pays strict attention to a decision as to make or buy. And in many instances, price determines the answer. If it can be bought cheaper from a supplier, most companies will buy.

communications at chevrolet

While Chevrolet has found it advantageous to centralize its engineering function, it has found it equally desirable to decentralize manufacturing facilities. Here, the keystone in effective communication between engineering and production is the production engineering staff which serves as the liaison between these major functions. Inciden-

tally, this group of specialists is part of the product engineering department, responsible to the chief engineer.

To illustrate how communication is developed at Chevrolet, consider a hypothetical case involving the design of a newly styled truck cab. Starting at the point where management approval has been gained, it is essential to have the manufacturing department enter the picture as early as possible. The production engineering staff, therefore, arranges a meeting of manufacturing representatives and design engineers in the styling studio, if possible.

Here they study the clay models as well as styling layouts to determine how to cut the cab into panels of such size and proportions that they can be adapted to existing or planned facilities and produced economically. In addition, the panels must be made sufficiently compact for efficient handling and shipping since they must be transported to assembly plants throughout the U. S. A.

Following preliminary cost studies, engineering proceeds with experimental layouts and detail drawings. At this stage production engineering literally looks over the designers' shoulders and brings in the proper manufacturing people; or makes appointments for engineers to go to the various plants with rough sketches, layouts, or models of components to determine how they should be designed for optimum production.

At this stage it is often necessary for a plant manager, his master mechanics, and processing groups to meet with design and production engineers to thrash out a particular problem. It may also be necessary to call in representatives of outside manufacturers in connection with parts that may be purchased.

By now the design engineer has a good knowledge of what is required and is in a position to issue building work orders for experimental parts. Many experimental parts or unit assemblies are built in manufacturing plants to make the manufacturing personnel familiar with the design in its experimental stages. Engineering cost estimates are compiled at this point, a sizeable cost estimating department being maintained by engineering for this purpose.

A mockup is built to check on general arrangements, clearances, and placement of other components. This is helpful for study on the part of assembly plant personnel.

The program planning group (in engineering) compiles a schedule of experimental releasing, building, and testing. Lead times were developed early in the program and form the basis for all schedules.

Following proving ground testing, Chevrolet arrives at the final design stage. As final production drawings are prepared, the production engineering department takes over to place the design in the hands of manufacturing. This is the most important phase of liaison between design and manufacturing. Changes must be expedited quickly. Designers are taken into the plants to resolve problems with tool designers.

About three months before the start of production the manufacturing department sets up a pilot assembly line to resolve assembly problems. Production engineering participates actively in this operation and design engineers are called in frequently.

Production begins in the manufacturing plants and the production engineering group is then on the alert for problems in actual manufacturing. Most of the Chevrolet plants have a resident engineer and the larger ones an engineering staff to work closely with design engineers.

Next follows the start of production at the assembly plants. Many of the design engineers and sometimes some of the drafting room people go with the production engineers to the assembly plants to assist manufacturing in getting the lines started.

When vehicles are delivered to dealers and into the hands of customers, the production engineering field staff works with the service department field organization to resolve problems arising in the field.

The production engineering staff also maintains extensive test equipment in the plants and works constantly toward product improvement, cost reduction, and source development. Manufacturing cooperates closely in this work and also conducts studies to improve their own methods.

communications at cummins

At Cummins Engine Co. the procedure for launching a new design or major redesign is informal and is handled cooperatively through three major divisions: research, engineering, and operations. The latter consists of the manufacturing, quality control, purchasing, and personnel areas.

As projects are cleared by management, the design engineer takes over and develops the new design in rough form for engineering and management review. This provides the basic design for hard-

SERVING on the panel which developed the information in this article were:

panel leader:

C. A. Lindblom, International Harvester Co.

panel secretary:

J. Geschelin, Chilton Co.

panel members:

R. R. Burkhalter, Dana Corp.

C. H. King, Clark Equipment Co.

R. S. Plexico, General Motors Corp.

B. E. Ricks, Thompson Products, Inc.

C. B. Sheerin, International Harvester Co.

J. C. Walter, Cummins Engine Co.

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continued

lining and detailing of drawings. It is at this point that coordination of engineering-manufacturing takes hold.

As the detailing of design progresses the engineers call in or consult with manufacturing to determine whether the design can be produced by existing machinery, as well as changes that might be required to facilitate production on existing machinery. Or if new tools or methods are indicated, manufacturing is called in to enable them to assign an individual to begin preliminary contracts for the procurement of such new equipment.

Subsequent to field qualification it is desirable to make a limited production run on the new parts. At this time engineering and manufacturing representatives review the design closely since it is the last opportunity for making changes or modifications before going into production.

After the new design is in production, the production engineer in the engineering division, who is basically a liaison engineer, works between the engineering and operations division to take care of day-to-day problems.

communications at thompson products

Consider now the case of a parts maker producing components exclusively. This is exemplified by the Michigan Div. of Thompson Products, Inc., producing steering linkages and their components. Here, the liaison between engineering and manufacturing has been made as simple as possible by physically locating product engineering and manufacturing engineering side by side in the same area.

It may be noted that the chief engineer in this plant is in complete control of the product from the experimental stages to the production tooling stages. Both product and manufacturing engineering are under his jurisdiction.

Meetings are held with the heads of these departments on every major engineering design problem. Tooling and production standards are settled at this stage before the design is frozen.

To illustrate the system of communications here, consider a new product as presented by experimental engineering while the development is in its early stages. At this point information on the new product is presented to sales, tool design, estimating, industrial engineering, and product engineering. A cost estimate is made to determine the extent of new capital equipment where needed. This establishes a starting point for estimating the cost of the new product.

Product engineering and manufacturing engineering then work as a team to suggest and prove alternate designs that might incorporate changes such as a shift from forging to a stamping, for example. Such recommendations are made to reduce new tooling expenses and make better use of existing equipment.

This cooperative effort is informal but quite effective. Proposed designs are walked through to manufacturing engineering so as to discuss the project while it is in the talking stage, making a product engineer available for the purpose of discussion. If manufacturing engineering is not satisfied at any point, they call in the heads of product engineering and the factory to resolve the matter. This procedure usually settles the problem. But if higher authority is required, they will call in the chief engineer and vice-president of the division to make the decision.

In all of these operations purchasing is in direct contact with manufacturing engineering. Purchasing always checks with outside suppliers on the making of components against the cost estimates developed by the division. At Thompson Products price invariably determines whether to make or buy.

communications at dana

What of the problems of a parts maker. Dana Corp. uses a system approach. Dana has a multiplant operation producing such components as transmissions, clutches, universal joints, and axles. A combination of divisionalized manufacturing and product engineering results in coordination of both areas on an intimate basis since the products are well defined and are completely divisionalized.

At Dana the manufacturing personnel serve as consultants to the designers while a new design is being created so as to take full advantage of existing equipment and tooling; also to take advantage of the latest process techniques. Product engineers, in turn, serve as consultants to manufacturing on new developments concerned with equipment and processes. In this manner both manufacturing and engineering are aware of proposed new products, new processes, and new equipment.

In addition to the day-to-day routine liaison work, regular monthly product division meetings are held with representatives of engineering, manufacturing, and top management. At this meeting all major developments are reviewed and if any policy decisions are required they can be made on the spot by top management executives.

Dana also has a staff estimating group, including cost analysis, charged with the responsibility for determining if a part can be purchased more economically than it can be manufactured. This group is also instrumental in gathering and presenting data on optional designs such as the use of forgings, stampings, or castings. They also review manufacturing requests for design changes on existing parts before such changes are incorporated on drawings. When dealing with cost reduction problems, this group assigns a product engineer to work as part of a team with purchasing and process engineers.

communications at clark equipment

Operation of flexible task force committees provides the communication between engineering and manufacturing in the automotive division of Clark Equipment Co.

Consider the case of an air suspension system launched by the company some short time ago. The case study begins at the point where engineering samples have been built and tested, preliminary cost estimates made, and a market research report filed with management.

The general conclusion was that the product was good but the assembly was too heavy and would cost too much in a competitive market. At this point the vice-president of the division called together the key personnel from sales, engineering, manufacturing, purchasing, standards, and cost analysis. Here the facts were presented and it was concluded that redesign would be required to reduce weight by 25% and reduce cost by 30% without affecting the operational characteristics of the suspension system.

The next step was to appoint a committee to study the problem and report back at some set time. The committee in this instance was composed of a cost analyst, product engineer, purchasing representative, and methods engineer. This committee, typical of the general attack on problems, requires aggressive, cooperative people with the initiative to accomplish the desired result.

Progress was slow at the start while everyone concerned was evaluating the problem and breaking it down to the specific areas in which improvement can be made. Eventually the sample system was torn down and the components spread out for easy examination. Then representatives from the foundry, forge, sheet metal, and machine shop, as well as qualified vendors were called in for counsel as to ways and means of reducing cost and weight.

After several weeks of such activity the committee reported that the targets, 25% reduction in weight and 30% reduction in cost, could be met. Moreover, the committee came up with suggestions for an alternate construction for part of the suspension which promised an additional saving of 15% in weight and a further reduction of 5% in cost, if the suggestion could be safely accepted after extended testing.

At Clark the method outlined above is employed either formally or informally on every product before it goes into production. The composition of the committees changes somewhat with the character of the product to be studied but the principle of operation remains about the same.

communications at international harvester

Management at International Harvester Co. has become increasingly aware that close and effective liaison between engineering, manufacturing, purchasing, and sales is mandatory in developing competitive products. The availability of purchasing, manufacturing, sales, and accounting counsel to engineering permits development of designs which provide maximum adaptability to current conditions and takes into account the need for effecting future modifications with a minimum of expenditures.

Divisional planning is headed by the general supervisor and his assistant who report directly to the vice-president and general manager of the division. The staff of this group is assigned as follows:

1. **A Sales Consultant and Assistant,** directly responsible to the manager of sales, but assigned to divisional planning to keep engineering and manufacturing advised regarding sales requirements in new releases, to screen proposed new designs for salability, and to review current requests for special features, and the like.

2. **A group of Manufacturing and Design Consultants and Estimators** to collaborate with the engineering department and works personnel regarding the effects of proposed design changes on present plant and equipment facilities, tooling requirements, and such, as related to stampings and sheetmetal assembly, forgings, heat treating and castings, gear cutting and general machining, and engine, axle, transmission, and end product (final) assembly.

3. **A Purchasing Consultant and Assistant,** who are constantly in contact with current and potential suppliers as well as manufacturers of new materials and components.

4. **Two Cost Consultants and Assistants,** who develop preliminary cost estimates on new product designs, based on calculations submitted by the manufacturing and design estimators, and on quotations from suppliers. This group also develops and presents target costs of proposed new models, features, or modifications for management consideration.

5. **A Production Research Coordinator,** who maintains close liaison with the manufacturing plants and with engineering, primarily in relation to product cost improvement projects.

6. **An Office Methods Consultant and Assistants,** whose chief responsibility is to develop and adapt efficient procedures for disseminating information throughout the divisional operations by means of electronic data processing systems.

7. **An Engineering Release Coordinator and Several Release Analysts,** whose job it is to thoroughly screen all final engineering drawing and specification releases to insure that design is in accord with the concept approved by management and is in accordance with

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continued

procedural requirements to permit ready processing at works level.

8. **Stenographic and Additional Clerical Help,** which bring the departmental roll to 35 persons.

Perhaps the most important contribution of the group to improved economy is found in the continual searching-out processes in the preproduction stages. As new designs are conceived in the advanced engineering section, collaboration between design engineers and consultants of the group wring out answers to questions such as:

- Will the design satisfy customer demand?
- Can it be produced economically with present plant and equipment facilities?
- Can present tooling be modified, or is new tooling required?
- Should it be manufactured or purchased?
- Will new methods or materials reduce the cost?

Correct answers to these and many other questions, determined early in design development stages, tend to insure a final production release which will flow smoothly into economical manufacture.

Another area of cost improvement is the research into improved methods and new or improved materials for the current product. In this connection divisional planning coordinates the efforts of the work's purchasing, planning, and production research with product engineering and engineering research and development.

To Order SP-322 . . .
. . . on which this article is based, turn to page 6.

Missiles and supersonic aircraft may use pneumatic systems because of

Answers Found to 1000F Wear and Galling Problems

Based on report by

C. H. Cannon
Lockheed Aircraft Corp.

METALS, lubricants, and fittings have been found which will work in a 1000 F, 5000-psi pneumatic system being developed for missiles and supersonic aircraft. Six months of testing at Lockheed's Georgia Division produced high-temperature parts that would withstand the wear and galling that occurs when hot surfaces rub together in valves and actuators.

Excellent wear characteristics resulted with Haynes Alloy No. 25 and steel (Inconel X) flame plated with Linde LA-2 aluminum oxide. Inconel X has superior creep and strength properties when properly heat-treated. The "hot-finished" Inconel X received from the mill is first rough machined and then heated to 1625 F for 24 hr and furnace cooled. In reality this is a low-temperature solution treatment for maintaining small grain size. Subsequent age-hardening for 20 hr at 1300 F develops maximum strength at temperatures up to 1100 F.

One actuator cylinder is made with an Inconel X barrel with a Haynes Alloy No. 6B liner pressed in and machined to a finish of 2 microin rms. Using a Koppers carbon-type seal, a static break-out friction of only 8 lb was found for a 4-in. diameter piston with a 2-in. diameter piston rod.

Three dry film lubricants have proved successful. They are Electrofilm 2006, Everlube, and Metal Matrix. The latter two, however, are susceptible to scaling.

Inconel X is used successfully for fittings and tubing at 1000 F. Threads are silver plated, electrolized, or coated with dry film lubricants to prevent galling. The fitting sleeves are electrolized to increase hardness so the sleeve will take a deeper bite into the tubing.

Static seals were tested and the best to date are the WADC boss seal and the Autonetics seal. These are the only two that showed absolutely no leakage in several installations. During tests of four types of seals, the leakage varied from 0 to 80 cc per min.

THIS ARTICLE is based on the second progress report made to SAE Committee A-6, Aircraft Hydraulic and Pneumatic Equipment. It was presented at the May 7, 1958 meeting held in Fort Worth, Tex.

The design goal is a 1000 F. 5000-psi, 500-hr life pneumatic servo system. Design and material information was previously reported in the April 1958 issue of the SAE Journal on p. 70.

Abridgment of an

SAE Central Illinois Section Paper

LeTourneau-Westinghouse's New 32 Ton Rear Dump Truck

Based on paper by

Ralph H. Kress

LeTourneau-Westinghouse Co.

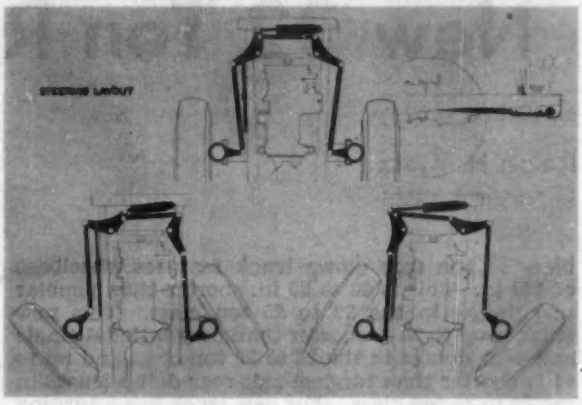
New 32 ton rear dump truck features wheelbase of 129 in. This is 40 to 50 in. shorter than popular rear dumps in the 22 to 25 ton class. This new truck is up to 20 ft shorter than conventional single axle rear dumps in the 22 to 25 ton class and up to 45 ft shorter than tandem axle rear dump trucks in the 30 to 35 ton class. The new truck has a turning circle of 43 ft which is approximately the same as the average passenger car.

A short wheelbase is not wholly responsible for the short turning circle. A new Hydrair suspension and steering design permits 45 deg front wheel turning angles. The constant body slope provides a lower center of gravity as a large portion of the payload is carried below the normal floor level of conventional rear dump trucks. This low center of gravity also provides greater stability which, together with the new suspension, makes the shorter wheelbase practical.

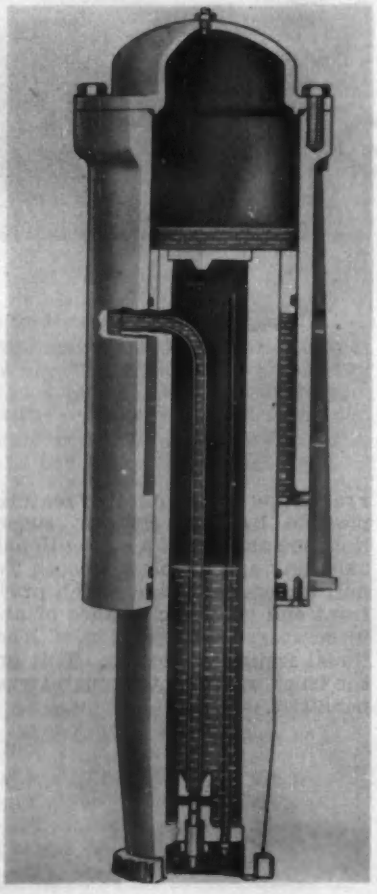
Front view reveals another feature made possible by the Hydrair suspension. Note the absence of a conventional front axle making possible a smooth Tournapull underside design which provides a front end ground clearance of about 24 in. compared to about 12 in. with conventional front axle design. This provides the truck with greater rough terrain capabilities.

(continued)

. . . LeTourneau-Westinghouse's New 32 Ton Rear



Steering layout showing connections to both front wheels. The drag links to both front wheels are parallel to the frame side rails, and the cross connecting links to provide the proper steering geometry are concealed and protected from rock damage above and in back of the front bumper. All bearing connections are sealed for life and should require no attention. This elimination of grease nipples has been carried throughout the truck with the exception of the universal joints and water pump which may require greasing at 500 hr.



Cross-section of the new Hydrair suspension unit which provides excellent stability for fast travel over uneven terrain.

Each wheel suspension unit consists of two parts: A stationary cylinder secured to the frame and a moving piston secured to and operating with each wheel.

The large compression chamber in the cylinder above the piston head contains a layer of oil for lubrication. The area above the oil is filled with inert compressed nitrogen gas which contains no moisture or oxygen to cause corrosion on the inside of the cylinder. Internal pressure in this chamber ranges from 150–300 psi.

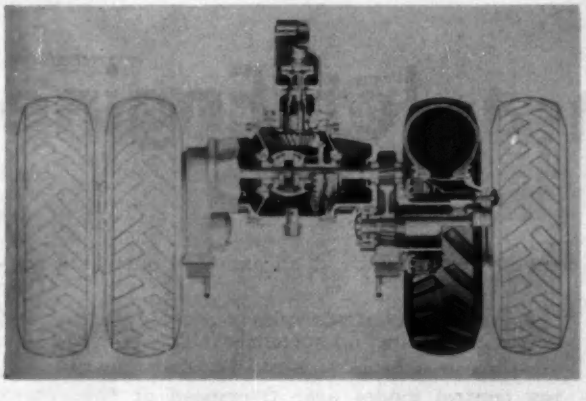
The piston, which works inside the cylinder, has a flanged head. The area directly below the piston head, and at its outer circumference, is a circular chamber filled with oil. This chamber is connected to the interior bore of the lower piston section by a tube which terminates in a control valve at the extreme bottom of the piston. This valve controls the rate of oil flow from the circular chamber to the interior of the piston and makes the whole unit act as a giant two-way shock absorber which permits the wheel to follow ground irregularities, but snubs its return action, thereby giving a smoother ride.

Compressed nitrogen is also retained in the interior of the piston which increases in pressure as the downward motion of the piston forces oil from the circular chamber into the interior of the piston.

If downward travel of the piston comes within ½ in. of the lower cylinder body, the internal pressure becomes sufficient to lift the wheel off the ground. This safety feature prevents metal-to-metal contact of the piston with the cylinder body.

Dump Truck (continued)

Individual front wheel action of the Hydrair suspension as one wheel passes over a rise in the road while the other wheel remains on level ground.



New type rear axle used with 32-ton dump truck. Note that the final reduction is accomplished with a large pinion and bull gear. This design has been successfully used in the Tournapull scraper axle where extremely difficult service is normally encountered and where it is common to slip the large tires on the drive axle when loading the scraper. A further advantage of this rear axle design is that the entire gear train consists of only 6 gears compared to 12 gears in the conventional planetary geared axle.

The axle is held in position by a large ball and socket ahead of the bevel pinion shaft and by a cam roller that is guided in a channel at the rear of the large bevel gear.

Installation of the Hydrair suspension on the rear axle. Here the two Hydrair units carry and control vertical loads only and are mounted with ball socket joints on each end. The internal operation is the same as the front units. The rear axle is held in position by mechanical means.

To Order Paper No. S75 . . .
. . . on which this article is based, turn to page 6.

200 to 200,000,000 decisions are needed to Design a Jet Engine

Based on paper by

A. J. Sobey
Allison Division, GMC

"WHAT is the engine doing now?" and "How can I change it?" are the two questions the engineer must answer when he is picking the mode of control of a jet engine for a specific application. To find the best answer, he can choose from 200 combinations for a simple engine or from 200,000,000 combinations for a complex two-spool, afterburning, supersonic engine. Before he can start choosing modes of control, the characteristics of the engine and airframe must be known, and when he's finished, the hardware must be built to implement his decisions.

For each regime of operation (such as starting or acceleration), there is a series of independent variables (such as fuel flow), which can be used for control, and a number of parameters (such as turbine temperature or engine rpm) which can be used for biasing the control schedules. The modes of control that are possible for these conditions can be subdivided into three classes:

- Physical limiting control modes to protect the engine against damage or malfunctions which could result in loss of power.
- Thrust control modes to provide the desired engine performance at all expected operating conditions.
- Transient control modes to provide starting and power changes at all specific conditions.

Typical functions included in the physical limiting control modes are: Overspeed of the rotors, maximum combustion-chamber pressure, maximum turbine temperature, combustion blowout, and instability.

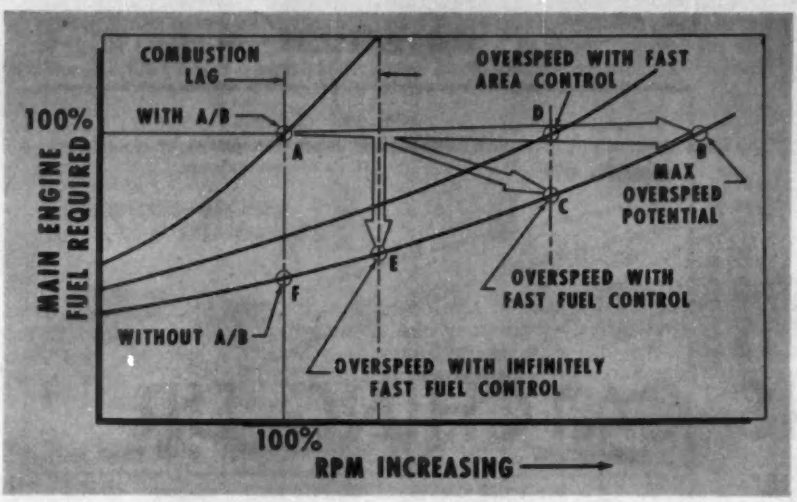
Thrust control modes must satisfy take-off, cruise, loitering, idle, and braking power regimes with the best compromise between thrust and specific fuel consumption.

Finally, the transient control modes account for the starting and acceleration of the engine.

Making a "Mode of Control" Decision

One example of the design decisions involved is the prevention of rotor overspeed on a gross transient. Engine overspeed limitation on a conventional jet engine with a variable jet nozzle area can be supplied either by reducing the fuel flow or closing the jet nozzle area. Steady state control performance will support either choice. However, protection against afterburner blowout is a severe transient case that helps make the decision.

The effect of afterburner blowout on fuel flow and engine speed is shown above as a jump from point



LIMITING ENGINE OVERSPEED when afterburner blowout occurs could be done by fuel or jet-nozzle-area control. Although fuel control has a built-in combustion lag time, it is still the preferred system because of its relatively lighter weight.

Control System

A to point *F*. This is effectively a 50% decrease in engine fuel requirement caused by the sudden elimination of the afterburner combustion "restriction" downstream of the turbine. If there were no control on the engine, it would accelerate to overspeed point *B*.

Using a reasonably fast fuel control would only keep the engine from overspeeding past point *C*. Even if a perfect fuel control is used, the overspeed point could never be better than point *E* because of the combustion delay time of the fuel already in the burners.

An infinitely fast jet nozzle, however, has the potential of reducing the overspeed to the lowest possible value. When a very fast jet nozzle is designed to do this job, it turns out that just to match the performance of an ordinary fuel governor (point *D*) will require 100 times more weight in the nozzle actuating system. This is because of the large forces that must be overcome when restricting the airflow out of the engine. Consequently, the fuel governor will be used for most afterburning engines.

The engine parameters used to detect the blowout must also be selected, usually in conjunction with control of other engine functions.

If the equivalent problem is inspected from the standpoint of a turboprop with a fast responding propeller and a less severe overspeed requirement, speed control by use of the propeller might be the answer.

Each possible combination for controlling a regime of the engine does not have to be examined with the care indicated in this example. Many redundancies show up, and experience automatically eliminates many lines of investigation. Finally, an analog computer can be used to help decide between the remaining combinations possible for a complex engine.

Other Examples

Other control mode examples discussed in the paper include:

Compressor discharge pressure limitation.
Range of thrust control available.
Optimum control system weight to satisfy specific mission.
Optimization of control system functions.
Inlet matching for optimum thrust.
Idle thrust requirements.
Effect of idle thrust on aircraft performance.
Basic modes of acceleration control.
"Closed-loop" acceleration control modes.
Effect of acceleration on tolerance controls.
Effect of acceleration time on aircraft performance.
System compatibility requirements.

To Order Paper No. 49A . . .
. . . on which this article is based, turn to page 6.

SAE LOOKS OVERSEAS

This feature is an activity of the SAE OVERSEAS INFORMATION ADVISORY COMMITTEE.
M. A. Thorne, chairman.

EUROPE IS CATCHING UP on Quantity Production Methods

by **J. E. Adams,** vice-president — manufacturing, White Motor Co., whose recent visit to England and the Continent inspired these observations on industrial and economic conditions there.

Modern Techniques Used

United States no longer has a monopoly on quantity production, advanced-design machine tools, quality, and automation. The progressive European automotive factories are making use of the most modern techniques wherever practical. The low volume producer, like low volume producers in the United States, is still largely on a job-shop basis. The machine tools in European factories come not only from the United States, but from every country in Europe. It is not uncommon in a machine shop to see a mixture of American, German, French, Swiss, and English machine tools working side by side, each doing the job for which it is best qualified.

Worker Productivity Higher

One feature of European production is that productivity per worker seems to be higher than in United States. It is difficult to say exactly how much work each man is turning out. . . . But anyone who has spent many years in factories knows that it is possible to sense and observe what is happening. This is largely borne out in comments of European manufacturers who have been in American factories.

Both men and supervisors on assembly lines and in machining departments start to work when the bell rings and work until quitting time. This is true in the afternoon as well as in the morning. Many factories have one hour lunch periods, but then the workday is longer.

Much On-The-Job Interest

At various work points, there seemed to be a great desire to explain operations in detail and the application of the equipment. On one engine line, a worker insisted on completely disassembling a new centrifugal oil filter which his company was using to show how it worked.

With this on-the-job interest, lower wages, and ability of the European countries in general to deal with soft currencies — which allows payment in anything from olives to piasters — it is little wonder that so much of our export market has been lost. How to recapture it is another thing.

France's Industrial Production Climbing

In France, despite the numerous political upheavals, the economy is booming. Industrial production has climbed every year since the war, and is still climbing. The standard of living continues to improve. For all practical purposes, there is no unemployment in France, nor need anyone who is willing to work go hungry.

Renault Output 1100 Dauphines Per Day

For example: Renault, the largest automotive manufacturer in France, is building approximately 1100 Dauphines per day in a new factory outside of Paris. This car is slightly larger than the Volkswagen. This brand new factory has the latest type of automated assembly and other automatic equipment. The backlog of orders is claimed to be in excess of one year. In 1954, automotive parking lots for French factories were prac-

tically nonexistent. The parking lot outside of this factory contains some automobiles, many motorcycles, and scooters. The streets approaching the Paris factory of the same company were jammed with the employees' automobiles.

Production Increase Operations in other French automotive factories are also of the highest order. One truck factory in Lyons has increased its production several fold since 1953. Equipment was up-to-date and work effort excellent. Next year's models and advance designs were exhibited by the management.

Trucks Mostly Diesel Powered The whole trend of truck design in Europe has changed since the War. Prior to the War, the average European truck was underpowered and reminiscent of vehicles built some 20 years ago in the United States. Road speeds were very low and acceleration obviously poor because of the small engines. Today, engines are large enough to haul loads comparable to those in this country at speeds of 50 and 60 mph. Engine sizes are rapidly approaching those of American truck engines. European trucks are almost exclusively diesel powered.

Fiat — Italy's Largest Automotive Manufacturer Northern Italy — the country's industrial center — is experiencing a boom similar to that of France. A typical example is the famous Fiat works in Turin. This company is actually an industrial empire, making much of its own raw materials and assembling end products. Its passenger cars are as common on Italian roads as the Model A Ford used to be in United States. Fiat is by far the largest automotive manufacturer in Italy. . . . Italian trucks are designed largely as right-hand drive units because the winding mountainous roads make it desirable for the driver to be able to watch the edge of the road. A watcher sits on the left to watch traffic. There are several other small manufacturers of heavy-duty trucks in Italy. . . . but Fiat has a dominant position and is becoming increasingly important in the export market.

Possibility of Lower Demand Concerns German Automotive Manufacturers Though Germany was not visited, conversation with people operating factories there was most enlightening. While business continues to boom, there is a restiveness in the automotive industry which indicates concern over a possible lower demand. German productivity has been tremendous since the war. Quality has been excellent. . . . And industries other than automotive do not anticipate a problem because of the tremendous rebuilding and rehabilitation job that has to be done. German trucks, like the French and Italian, have gone to more power and bigger loads.

Europe's Long-Range Economic View Good In general, Europe has such a long way to go to raise its standard of living to that comparable with ours — including housing, automotive products, and all the things we take for granted — that, barring political upheaval and side effects of world affairs, it is possible an increasing economy can be experienced for many years. As one European executive put it, Europe is in about the same position as was the United States during the early twenties . . . and it should be possible to parallel American economic growth from that period to the present. Tremendous housing projects are being built everywhere in Europe. These are of modern design, and in most instances, are replacing substandard dwellings.

England has a different economic picture. Unemployment is growing, truck production has been reduced, and automotive factories are no longer running at capacity. Manufacturers are concerned that they may face a problem similar to that in United States. Everything from high prices, high taxes, labor troubles — even the United States — has been labeled as the cause of the situation. There is no question that the condition exists.

England is not in the same position as the Continent as to its industrial and economic growth. . . . because the average person has enjoyed a better standard of living than the Continent for some years. Industrially, Great Britain has been extremely progressive as the center of the Empire. Today, many of the markets in the Empire have been lost, or partially so, due to the aftermath of the War. There is, however, an aggressive attitude on the part of manufacturers. They are realistically approaching their problem by trying to build a better product for less money.

Better Product for Less Money — England's Aim

British trucks in general have much less horsepower than ours, and less than those on the Continent. British road laws make it mandatory for a truck to reduce its speed as the load increases. As a result, trucks can travel at perhaps 30 mph with a full load on level ground, but must crawl over hills at 4 and 5 mph. Serious thought is being given to the use of larger engines, and there is also the possibility of revisions in road laws.

About SAE

Barnard Parkins Martin Wright Ault

Weller Ferrall Dickerson Day Dilworth

Stewart Menking Massa Baldwin Foote

DR. DANIEL P. BARNARD, IV, 1952 SAE President, has retired from Standard Oil Co. (Indiana) after 33 years in the research department, the last 10 as research coordinator. In 1954 and 1955 he served as a deputy assistant secretary of defense in the Defense Department; and he plans to continue serving as a consultant to the Department after his retirement. He has served as president of the Coordinating Research Council, and has been active in many scientific and engineering societies. He plans to live in Bozman, Md., near Easton, where he has been building a home.

WRIGHT A. PARKINS, vice-president for engineering of United Aircraft Corp., has been named general manager of the newly formed Missiles and Space Systems Division. He will continue as vice-president. **ERLE MARTIN,** vice-president and general manager of the Hamilton Standard Division, has taken on the additional duties of general manager of the new Norden Division. Both men have been elected directors of the corporation.

DR. ALFRED K. WRIGHT, vice-president in charge of engineering of Tung-Sol Electric Inc., Newark, has been given the additional duties of vice-president in charge of operations and engineering.

THOMAS J. AULT, former president of several divisions of Borg-Warner Corp., has been elected to the presidency of Saco-Lowell Shops by directors of the Boston-based manufacturer of textile and automotive parts. He has been serving as president of Long Mfg. Division, Detroit, and its Canadian affiliate, Long Mfg. Co. Ltd. of Oakville, Ont.; and as president of Cello Products Ltd. of Galt, Ont., a subsidiary of Long. All are divisions of Borg-Warner Corp.

HARRY D. WELLER, JR., regional manager of the White Motor Co. in charge of the Eastern Region, has been named vice-president in charge of the region. He will have full responsibility for direction of sales and service activities in this area.

LORIN L. FERRALL has been elected executive vice-president of the Crucible Steel Co. of America. He joined the company in 1945 and was vice-president — operations prior to his new appointment.

JULIAN D. DICKERSON, who has been manager of steel production, succeeds Ferrall as vice-president — operations. Dickerson has been with the company since 1953.

DR. MAURICE J. DAY heads the newly formed Technology Department at Crucible Steel Co. of America. Formerly vice-president of research and development, he is now vice-president — technology. He has been associated with Crucible since 1954.

DAVID I. DILWORTH, JR., director of metallurgy, will assume broadened responsibilities in the new department including direction and coordination of metallurgical policies, standards and procedures; quality control methods; technical customer service; trade specifications, manufacturing standards and raw material specifications.

EARLE STEWART has been appointed executive vice-president of Vanguard Air & Marine Corp. He had previously been an executive with the Glenn L. Martin Co., and most recently had handled preliminary design for Vertol Aircraft Corp.

HEINZ V. MENKING has been named general director of product development for Reynolds Metals Co. Formerly, he was director of the transportation section of the product development department.

G. S. MASSA has been appointed a member of the board of directors and vice-president in charge of operations of Hydrodyne Corp., North Hollywood, Calif. He was previously associated with Com-Aire Products and Rocket Jet Engineering, serving as vice-president of these firms. Before that he was vice-president of Hydro-Aire, Inc.

WALTER D. BALDWIN has been appointed vice-president in charge of the newly formed automotive sales department of the United States Rubber Co., with headquarters in Detroit. With the company since 1935, he was assistant general manager of the tire division prior to his new appointment.

E. T. FOOTE has retired as vice-president of Globe-Union, Inc. He joined the company in 1928 as vice-president and general manager of the Union Battery Co., and has been a vice-president and director from 1929 to 1958.

R. WAYNE McLAUGHLIN has been appointed vice-president in charge of engineering for Elliot Co., a division of Carrier Corp. with headquarters in

Members

McLaughlin Pelizzoni Richards Fox Baeyertz

Smith Ford Mandy Bailey Dix

Gates Roberts Peters Hill Anisman

Jeanette, Pa. He has been with Carrier since 1945 and was assistant to the president of the corporation in Syracuse, N. Y. prior to his new position.

Three executive promotions in the Engineering Division of Mack Trucks, Inc., have been announced by **WALTER M. MAY**, vice-president — engineering: **WINTON J. PELIZZONI**, formerly assistant executive engineer, has been named executive engineer in charge of the Engine Design Department in Plainfield, N. J. **JOHN S. RICHARDS**, administrative assistant, has taken over the position of assistant executive engineer in the Vehicle Design Department in Allentown, Pa. **FREDERICK F. FOX**, assistant manager, has become manager of the Engine Design Department Laboratory in Plainfield.

FRANCIS P. BAEYERTZ, chief automotive engineer in the marketing department of General Petroleum Corp., Los Angeles, retired in June.

C. G. DAVEY has retired from the AC Spark Plug Division, General Motors Corp. He held the position of executive engineer.

L. B. SMITH has taken over the job vacated by Mr. Davey's retirement. In his new position, he will be in charge of AC's automotive test laboratory, model shop, and department sections for drafting, standards, material specifications, and administrative services.

JAMES J. FORD has been appointed general manager of the Fuel Injection Division of the Hartford Machine Screw Co., a division of Standard Screw Co. Prior to his appointment, he was sales manager of the Division in charge of products for the diesel engine industry.

ROBERT R. MANDY has become director of research and development for the Delman Co., Detroit. He was formerly engineering supervisor with Harrison Radiator Division, General Motors Corp.

PAUL C. BAILEY has been named manager of sales and manufacturing of the Brass Division of Bohn Aluminum & Brass Corp., Detroit. He has been sales manager of the division since 1954.

EDGAR H. DIX, JR., assistant director of research, Aluminum Co. of America, has been awarded an honorary degree of Doctor of Science by Carnegie Institute of Technology, Pittsburgh. His work has been concentrated in the area of corrosion resistance in the development of aircraft alloys.

JOHN B. GATES, former manager of the West Coast Division of Thompson Products, Inc., has been appointed general sales manager of the company's Michigan Group.

DONALD D. ROBERTS, formerly a sales engineer for the Valve Division of Eaton Mfg. Co., has become sales manager of the division.

T. F. PETERS has been made chief design engineer for the Flex-O-Tube Division of Flexonics Corp., Dearborn, Mich. He has been service engineer with the same corporation.

EUGENE F. HILL has been appointed market manager of the New Products Division of Wolverine Tube Division of Calumet & Hecla, Inc. Previously he had been manager of the chemical department, engineering staff of Ford Motor Co.

GEORGE F. ANISMAN has become chief applications engineer for Sundstrand Turbo, a division of Sundstrand Machine Tool Co. Prior to his new position, he was with the Dole Valve Co. as regional sales manager.

GEORGE J. ADAMS has become an automotive management consultant for the World Health Organization, Pan American Sanitary Bureau of the United Nations. His work includes consulting with Latin American nations on management of Transports Organization, used for eradication of malaria and other public health programs. Formerly, Adams had been a senior project engineer for the Detroit Transmission Division of General Motors Corp.

PERRY W. PRATT is vice president and chief scientist of United Aircraft Corp. Previously, he had been assistant engineering manager, Pratt and Whitney Aircraft, division of United Aircraft.

FRED T. MILLER has been appointed regional sales manager for Weston Hydraulics, Ltd., subsidiary of Borg-Warner Corp. Formerly, he was associated with Adel Precision Products, a division of General Metals Corp., where he held the position of vice-president in charge of sales and contract administration.

ROBERT A. PAETZ, formerly manager of advanced engineering requirements has been promoted to the post of western regional sales manager for the Tapco Group of Thompson Products, Inc.

LESTER M. GOLDSMITH has retired as general manager, engineering and construction, for the Atlantic Refining Co., Inc., where he has served for 42 years. He will now open an office as consulting engineer.

MARTIN J. POGGI has opened an office in the Seattle area as manufacturer's representative handling aircraft, avionic, and space vehicle accessories. Previously, he was district manager for the Cook Electric Co.

CHARLES W. SINCLAIR has been elected vice-president — engineering for all divisions of Kelsey-Hayes Co., Detroit. He has been with the company since 1911.

RUPERT L. ATKIN has been named to succeed Sinclair as chief engineer of the Automotive Division of the company. He joined the company in 1946 and was assistant chief engineer prior to his new appointment.

FRANK J. WEBER has been appointed assistant chief engineer of the Automotive Division. Weber joined Kelsey-Hayes in 1956 and was in charge of brake development prior to his new assignment.

R. A. EVANS has become development engineer with Canadian Car Co., Ltd. of Montreal. Previously, he was service engineer with the same company.

CLAUDE R. MASON, service manager for B. F. Goodrich Tire Co., has retired after more than 50 years of service. He joined the company in 1907; in 1923 he became operating manager of the Detroit district, and in 1930, service manager in Akron.

HORACE R. LOWERS was graduated in June from the Industrial College of the Armed Forces, Fort McNair, Washington, D. C. He was one of two civilians from the Department of the Army to attend the 10-month resident course. Lowers has returned to his position as special assistant for vehicles, weapons and infantry systems to the Chief, Industrial Division, in the Office of the Chief of Army Ordnance.

ROSS H. BEGG, JR., has been made assistant to the general manager at Pratt & Whitney Aircraft, Division of United Aircraft Corp. He has been with the engineering department for 22 years, and held the post of executive engineer at the time of his new appointment.

GEORGE M. C. C. ASSELBERGS has become field representative for D.K.W. Cars in Toronto, Ont., Can. Formerly, he had been chief of the technical department, Royal Dutch Touring Club, A.N.W.B. Toeristenbond, in The Hague, Holland.

CHARLES A. CASHION, formerly manager of the transportation section for the Koppers Co., Inc., is now sales manager for Moore Flesher Hauling Co., Pittsburgh.

FRED N. DICKERMAN has become assistant chief engineer for Georgia Division of Lockheed Aircraft Corp. Prior to this, he was chief preliminary design engineer for the division.

TIBOR F. NAGEY is now director of research, Allison Division, General Motors Corp. Previously he had been with The Martin Co. as director of the Nuclear Division.

LOUIS F. POLK has received an honorary degree of doctor of science from Miami University for his "contribution in advancing the arts of engineering, dimensional control and metrology." He is a director and group executive vice-president of Bendix Aviation Corp., and president of Sheffield Corp., a subsidiary of Bendix.

In the Defense Engineering Division of Chrysler Corp., **DR. PHILLIP W. LETT** has been named chief engineer, and **WALTER C. BEYER** is assistant chief engineer. They will report to **CHESTER C. UTZ**, executive engineer for the division.

Lett, who was assistant chief engineer prior to his new position, joined Chrysler in 1950.

Beyer joined Chrysler in 1927, and formerly was assistant chief engineer, product engineering, in defense operations for the division.

LEWIS R. HETZLER will supervise the newly formed Applied Science Department of the Delco-Remy Division, General Motors Corp. Formerly, he was assistant director of the Engineering Research Department.

The Automobile Manufacturers Association elected the following new officers at their annual meeting held in Detroit in June: **L. L. COLBERT**, president of Chrysler Corp., as president of the Association; **HENRY FORD II**, president of Ford Motor Co., as vice-president of the Passenger Car Division; **J. N. BAUMAN**, president of White Motor Corp., as vice-president of the Commercial Car Division. **HARLOW H. CURTICE**, president of General Motors Corp., was re-elected secretary and **ERNEST R. BREECH**, chairman of the board of Ford Motor Co., was re-elected as one of the directors.

DR. ROSS A. MCFARLAND has been named professor of environmental health and safety in the Faculty of Public Health, Harvard University. He is the director of the Guggenheim Center for Aviation Health and Safety at the School of Public Health. Since 1949 he has been associate professor of industrial hygiene.

Three former employees of the Nuttall Gear Division, Westinghouse Electric Corp., have moved to the newly formed Torque Converter and Transmission Department of Rockwell-Standard Corp. They include: **ROBERT R. MADSON**, design engineer; **WILLARD F. MEYERS**, engineering manager, transmission section; and **PHINEAS R. YOUNGS, III**, sales engineer.

SMITH BOLTON has been named treasurer of the Powder Metallurgy Parts Manufacturers Association. He is president of U. S. Graphite Co.

Obituaries

ANDREW D. GREY . . . (M'55) . . . editor of Chilton automobile manuals . . . associated with the Chilton Co. since 1934 . . . died June 18 . . . born 1910.

WILLIAM A. CHRYST . . . (M'12) . . . co-inventor of the automotive ignition system . . . one of the founders of Delco . . . retired as consulting engineer in 1947 . . . died June 4 . . . born 1887.

JOHN ROBERT FISH . . . (M'37) . . . president of Fish Carburetor Corp. for past 12 years . . . also research engineer . . . died May 8 . . . born 1894.

WILLIAM R. ENYART . . . (M'40) . . . president of Simmonds Aerocessories, Inc., was killed in a crash of KC 135 jet tanker scheduled to make a record round trip crossing of the Atlantic . . . served for many years as president of the National Aeronautical Association and honorary president of the Federation Aeronautique Internationale . . . died June 27 . . . born 1901.

GEORGE O. ABELL . . . (A'53) . . . west coast district manager, S. K. Wellman Co. . . . died April 19 . . . born 1900.

RAYMOND SHAW . . . (A'41) . . . president, Chek-Chart Corp., for the past 28 years . . . died Dec. 8 . . . born 1893.

JOHN G. HODNICSAK . . . (J'51) . . . development engineer, Michigan Division of Thompson Products, Inc., . . . had been with the company since 1952 . . . died May 17 . . . born 1927.

CARL H. FRINK . . . (M'37) . . . president, Frink Sno-Plows, Inc., . . . organized company in 1920 . . . died April 27 . . . born 1886.

CONRAD R. ROBIDOUX has been appointed factory representative for New York and the New England states by the George L. Nankervis Co. of Detroit. Previously, he had been a correlation engineer for Chandler-Evans, division of Pratt & Whitney Co., Inc.

DR. ROBERT J. NEBESAR has been appointed general manufacturing manager of Zenith Plastics Co. Prior to this, he was vice-president and chief engineer, Reinforced Plastics Division of Universal Moulded Products Corp. Nebesar is the author of many technical papers in the reinforced plastics field.

SHERMAN M. FAIRCHILD has been elected chairman of the board of directors of Fairchild Engine and Airplane Corp. He founded the company and served as board chairman until 1946, and is owner and president of Sherman Fairchild & Associates, Inc.

FRANCIS L. LaQUE, vice-president and manager, Development and Research Division of the International Nickel Co., Inc., presented a paper during the Golden Jubilee Meeting of the American Institute of Chemical Engineers in Philadelphia, June 25. The paper, entitled "Corrosion Mechanisms and Material Selection Methods," was presented at a symposium on materials of construction.

JOHN B. DUCKWORTH has become research coordinator in the Standard Oil Co. (Indiana) research department at Chicago. He joined the company in 1936, and was division director of automotive research at the Whiting, Ind., research laboratories prior to his new position.

Succeeding Duckworth at Whiting, is **HAROLD R. TALIAFERRO,** who has been section leader in the automotive research division. He has been with the company since 1940.

LAMONT ELTINGE replaces Taliaferro as section leader. With Standard since 1951, he has most recently been group leader in the research department.

THEODORE C. WAGNER succeeds Eltinge as group leader; he joined the company in 1954 and held the position of automotive engineer prior to his new appointment.

DONALD F. KEHN has joined J. M. Mathes, Inc., as account executive. Formerly, he had been with Kudner Agency, Inc.

PARKER BARTLETT has been appointed to the newly created position of sales manager for the AiResearch Mfg. division of the Garrett Corp. in Los Angeles. He was formerly with the corporation's Aero Engineering Division in Mineola, N. Y.

Cole and Chayne Awarded Honorary Degrees

Cole

Chayne

EDWARD N. COLE, general manager of Chevrolet Motor Division, General Motors Corp., and a vice-president since 1956 of GMC, has been awarded an honorary Degree of Doctor of Engineering by Lawrence Institute of Technology. The award "represents to some extent the nation's gratitude" for his:

- "great contributions to the advancement of engineering . . .
- ability to be practical as well as visionary in developing vehicles for both defense and peacetime living . . .
- inspiration to others by his drive for knowledge and attitude that nothing in engineering is impossible to accomplish . . .
- generous use of time and talents for the betterment of his fellow man. . . ."

Cole was 1950 SAE vice-president representing Passenger Car Activity.

CHARLES AUGUSTINE CHAYNE, General Motor's vice-president in charge of engineering staff, was awarded an honorary Degree of Doctor of Engineering from University of Michigan. Chayne, who "has strengthened the industry and earned a rich harvest of respect from institutions of higher learning in our country," was honored for his:

- "ability to weld together creative efforts of men with varying talents . . .
- special conscience above the ordinary . . .
- awareness of educational needs — and of social impacts and implications created by modern trends in transportation . . .
- earnest desire to give freely of time and thought for the encouragement of a rising generation of engineers. . . ."

Chayne was SAE councilor for 1953–1954.

LT.-GEN. JAMES H. DOOLITTLE was guest speaker at the dedication and first delivery ceremony of the Fairchild F-27 propjet airliner in Hagerstown, Md., June 22.

DR. OSCAR O. MILLER, supervisor of the steel section of the Research Laboratory, The International Nickel Co., Inc., has been elected president of the Technical Societies Council of New Jersey, Inc. The Council comprises 22 scientific, engineering, and technical professional societies that have branches or members throughout New Jersey.

HARRY H. WHITTINGHAM, vice-president of Long Mfg. Division of Borg-Warner Corp, has taken on the added duties of assistant general manager of the Division.

JEROME LEDERER, managing director, Flight Safety Foundation, received the first Monsanto Aviation Safety Award for "his many contributions to aeronautics by the promotion of aviation safety throughout the world in 1957". The award was presented in Houston, Tex., May 30, at the annual dinner of the Aviation Writers Association.

HAROLD F. WOOD, executive vice-president of the Wyman-Gordon Co., was elected to the Executive Committee of the Drop Forging Association at its 23rd annual meeting, held in Hot Springs, Va.

ERNEST F. FIOCK has recently become chief of the Research Section of Astrodyne, Inc., in McGregor, Texas. Formerly, he was director of the Technical Development Branch, Rocket Fuels Division, Phillips Petroleum Co. in McGregor.

Continued on page 130

SAE TECHNICAL BOARD MEMBERS inspected Bendix Aviation research facilities after a recent Detroit meeting. Currently under consideration is a new, more flexible Technical Board structure. Introduced by C. L. Sadler, the proposal is designed to speed handling of reports coming from the 32 technical committees now under the Board. Shown from left are: Arthur Prine (Bendix), C. L. Sadler, M. L. Stoner (SAE Staff), A. E. W. Johnson, J. W. Larson, M. J. Kittler, Joseph Lambertine (Bendix), Trevor Davidson, and R. H. Isbrandt.

NEW SPARK IGNITION ENGINE TEST CODE SUBCOMMITTEE is revising SAE's Gasoline Engine Test Code. Members expect to make their test procedures compatible with those recently set for the Diesel Engine Test Code. When completed, both revised codes will determine performance characteristics of 2-stroke and 4-stroke cycle engines. Shown from left are: Rex Robinson, Chairman Stephen Kalmar, C. E. Patterson, and F. B. Esty.

C COOPERATIVE
E ENGINEERING
SAE
P PROGRAM

NEW LUBE OIL FILTER TEST—The proposed SAE performance test for lubricating oil filters is near completion, according to Filter Test Methods Subcommittee Chairman R. J. Pocock (left). Also shown at a recent meeting are Subcommittee Members E. R. Adams and Sherrett Earle.

1958 SAE TECHNICAL BOARD
Oliver K. Kelley, Chairman

Peter Altman	M. J. Kittler
C. F. Arnold	A. A. Kucher
E. C. Brown	J. W. Larson
T. O. Davidson	W. M. May
A. P. Fontaine	Arthur Nutt
M. L. Frey	E. B. Ogden
W. H. Graves	R. W. Rummel
W. M. Holaday	C. L. Sadler
G. J. Huebner, Jr.	E. C. Smith
R. H. Isbrandt	D. D. Streid
A. E. W. Johnson	E. C. Wells

A. E. Williams

TO EASE SUPPLY HEADACHES, the Defense Department has asked that their engine accessory standards be coordinated with SAE's. A special Engine Committee group will study the proposal's implications.

R. F. Harvey (left), Defense Department, stressed the importance of industry-government coordination in war time at a recent meeting. At right is Engine Committee Chairman J. F. Greathouse.

DONALD E. MANNING, Pratt and Whitney Aircraft, has been appointed chairman of the hard-working editorial consultants group of the Aeronautics Committee's Aeronautical Material Specifications Division.

This special 3-man team is responsible for the technical and editorial accuracy of SAE's 808 existing AMSs. Each year they analyze and coordinate hundreds of industry comments.

In 1957, a total of 128 AMSs were circulated to the Technical Board after being reviewed by this editorial group. Of these, 59 were new and 69 revised.

Over ten and a half million AMSs have been sold by the Society since 1940 when the first specification was issued.

The 300 engineers who are currently developing AMSs represent a cross-section of materials experts. Their prime objective is a quality specification for use by the aircraft, missile, engines, and parts and accessories industries.

A unique feature of these documents is that they are accepted by the military services.

Serving with Chairman Manning, who is a design metallurgist for his company, are H. B. Fernald, who is a chief project engineer at Wright Aeronautical Division, Curtiss-Wright Corp., and G. F. Kappelt who is chief metallurgist at Bell Aircraft Corp.

NEW HEAVY-DUTY BRAKE FLUID SPECIFICATION (70R3) — SAE's new 70R3 brake fluid specification which calls for a minimum boiling point of 375 F is now available as TR 203 from the Society's Special Publications Department. Because of industry demand, it has been printed in advance of its appearance in the 1958-59 SAE Handbook.

Fluids made to the new spec are intended for severe service where brakes are heavily loaded, have low heat dissipation, or are applied repeatedly in hot weather.

TR 203 also contains the 70R1 requirements which are considered safe for use in new cars under all expected conditions.

LIQUID COOLING SYSTEMS—The latest on liquid cooling systems in automotive vehicles will be included in SAE's Maintenance of Automotive Engine Cooling Systems Manual which is being revised by the new Cooling System Maintenance Subcommittee of the Transportation and Maintenance Technical Committee. The revised manual will cover the construction, function, and operation of automotive liquid cooling systems as well as driver and mechanic preventive maintenance procedures, according to T & MTC Chairman R. L. Douglas (left) and Subcommittee Chairman F. A. Gundlach (right).

Latest Missile Data At Aero Meeting

A FULL day of confidential sessions . . . primarily for designers of missiles and high-speed military aircraft . . . open sessions on missile guidance, handling, and storage . . . are some of the outstanding features offered at the 1958 National Aeronautic Meeting. To be held September 29 through October 4 at the Ambassador Hotel in Los Angeles, this year's Aero Meeting will have the biggest engineering display ever staged at an SAE meeting, as well as technical sessions covering many phases of aeronautical engineering.

For the military aircraft engineer topics include escape systems for military aircraft and constant speed drives . . . for the airlines engineer sessions on noise supression, air-conditioning systems in the DC8 and Electra, how to use the new turbine transports to best advantage, selection and training of pilots for turbine transports, how to handle and filter turbine fuels . . . for the powerplant engineer well-rounded sessions include nuclear propulsion, and powerplants for VTOL aircraft. By popular demand, SAE Committee S12 on Aircraft Shock and Vibration is preparing a session on shock and vibration problems again for this year.

Another result of popular demand is the expansion of engineering display facilities. This year the whole lower floor of the Ambassador will be devoted to 120 display booths showing the latest developments in everything from components of missile systems to high temperature materials.

You'll . . .

be interested to know . . .

PLANNING FOR PROGRESS COMMITTEE Chairman R. J. S. PIGOTT reports that PFP Committee has crystallized its program to the point where it is ready to make a final report to Council at its next meeting. At that time, he says, the Constitutional amendments required to bring about the changes in the Society structure proposed by PFP will be ready for presentation by the Constitution Committee.

Chairman Pigott further reports decision on the names of the top groups to be proposed by the Committee as:

Board of Directors (Council)
Engineering Activity Board
Technical Board
Sections Board

●

The modus operandi of the Science-Engineering Advisory Committee, said its chairman DR. L. R. HAFSTAD recently, is to focus on, and explore fully a few problem areas rather than to give surface treatment to a wide area. Typical of the subjects for exploration selected at the Committee's last meeting are:

- MEASUREMENTS — the common denominator in all phases of automotive engineering and research where information exchange can be of considerable value;
- HUMAN AND ENVIRONMENTAL ENGINEERING — in an endeavor to furnish the link between research and the practical application of research findings in design of automotive equipment.

●

Recent reappraisal of MEETINGS COMMITTEE objectives and responsibilities bids fair to result in even better integration and broader scope for National Meeting programs.

Improving the technical quality of papers is a main consideration, Chairman A. O. WILLEY says. As a first step in this direction, he has delegated Dr. Lloyd Withrow the task of studying the situation and coming up with specific recommendations for Activity and Advisory committees.

A "NEW LOOK" FOR SUMMER MEETING may be in the offing, too. The increase of technical information generated in SAE makes Summer Meeting more essential than ever as an outlet for this material. How best to do this is now the subject of study by a subcommittee, which is considering:

- The Society's objectives in operating a Summer Meeting. . . . Is the present format adequately meeting these objectives?
- How even greater participation of Activity and Advisory Committees may be obtained;
- The most desirable compromise between technical and social functions so that no technical "meat" will be sacrificed.

●

H. W. McFARLAND, Marquardt Aircraft Co., has been appointed a member of the Aircraft Powerplant Activity Committee to serve for the remainder of 1958.

●

CONSTRUCTION AND INDUSTRIAL MACHINERY engineers will be kept informed of latest developments in their industry via an SAE-CIM Newsletter. This will be produced by the CIM Advisory Committee as a regular feature, CHAIRMAN G. W. MORK reports. P. J. SPERRY of IHC (recent appointee) is heading up a Publicity Subcommittee charged with working out the details.

Chairman Mork also reports that the CIM Advisory Committee met recently with officials of the Construction Industry Manufacturers Association to acquaint them with SAE technical activities and reports.

In addition to P. J. Sperry, Chairman Mork announced the appointment of P. J. Carroll, Euclid Division, GMC, as a member of the CIM Advisory Committee.

●

OVERSEAS INFORMATION COMMITTEE Chairman M. A. Thorne reports a wide range of topics under way for the Overseas section of SAE Journal.

Technical impressions following a trip to Russia . . . little known phases of European automobile industry . . . new and advanced German universal joint design . . . European sports cars . . . and another analytical story on trends exposed at the 1958 European automobile shows . . . are expected for future issues, with many more in the offing.

The Committee is also keeping in touch with the Nuclear Energy Advisory Committee for stories that may result from some of the forthcoming international conferences on nuclear energy.

Chairman Thorne reports too that arrangements have been completed with Capt. John Jay Ide, vice president of Federation Aeronautique Internationale, for coverage of the FAI conference to be held in Russia (for the first time) in 1959.

●

INDIANA SECTION'S territory has been expanded by the inclusion of the Ohio counties of Williams, Van Wert, Defiance, Paulding, and Mercer.

●

POTENTIAL USES OF RADIOISOTOPES and the present status of thermonuclear power were the subjects of a recent round-table discussion of the NUCLEAR ENERGY ADVISORY COMMITTEE and its specially invited guests.

As a result, CHAIRMAN C. R. LEWIS reports, a request is off to the Meetings Committee for sponsorship of one technical session at 1959 Annual Meeting — the subject: "Industrial Uses of Radioisotopes." A subcommittee is working out the details.

Coverage of the Second Geneva Conference on Nuclear Energy has been arranged for. . . . A review paper on high energy acceleration and their uses is being requested for possible publication . . . .

SAE will continue to cosponsor the Annual Nuclear Congress. Though no definite plans have been made for the 1959 session, the "Congress potential" will be kept in mind when reviewing any papers received.

Dr. Michael Ference, director of Scientific Laboratories, has been appointed a member of the Committee.

- *equipment*
- *engines*
- *materials*
- *components*

First Milwaukee Display

. . . staged for the first time with the SAE National Farm, Construction, and Industrial Machinery Meeting, September 8–11.

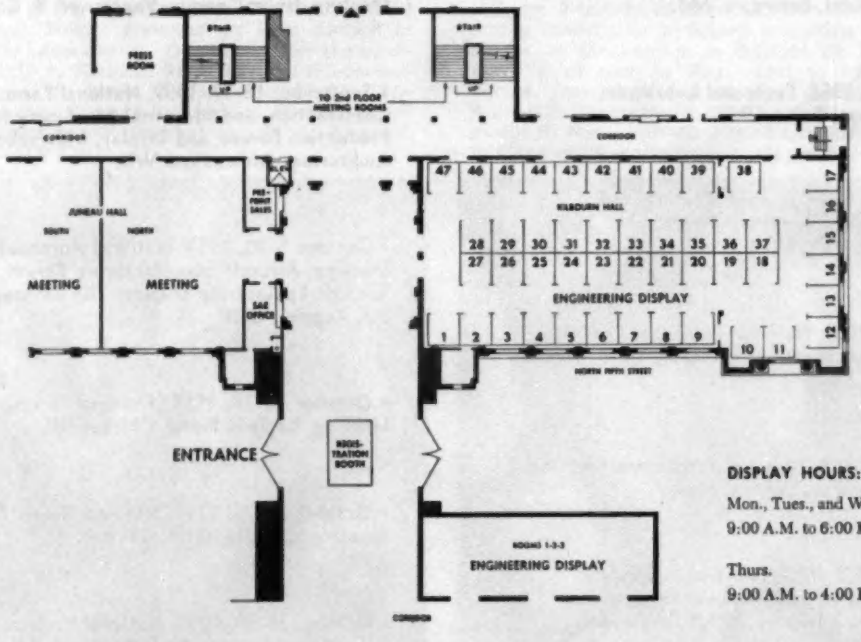
Another first is the move to the spacious Milwaukee Auditorium. Here all phases of the meeting will take place, and the following exhibitors will show the latest developments in equipment, engines, materials, and components:

BOOTH NO.

1. Twin Disc Clutch Co.
2. Twin Disc Clutch Co.
3. Twin Disc Clutch Co.
4. Huck Manufacturing Co.
5. Huck Manufacturing Co.
6. Anchor Coupling Co., Inc.
7. Aeroquip Corp.
8. American Bosch Div., American Bosch Arma Corp.
9. Clark Equipment Co.
10. PurOlator Products, Inc.
11. Young Radiator Co.
12. Kysor Heater Co.
13. Spray Products Corp.
14. Webster Electric Co.
15. Willys Motors, Inc.
16. Le Roi Div., Westinghouse Air Brake Co.
17. United Specialties Co. of Illinois
18. Bendix Aviation Corp.
19. Bendix Aviation Corp.
20. Detroit Diesel Engine Div., General Motors Corp.
21. Detroit Diesel Engine Div., General Motors Corp.
22. Chain Belt Co.
23. Wisconsin Motor Corp.
24. Wisconsin Motor Corp.
25. Bacharach Industrial Instrument Co.
26. Perfex Corp.
27. Waukesha Motor Co.
28. Bostrom Manufacturing Co.
29. Continental Motors Corp.
30. Continental Motors Corp.
31. Parker-Hannifin Corp.
32. Delco-Remy Div., General Motors Corp.
33. AC Spark Plug Div., General Motors Corp.
34. AC Spark Plug Div., General Motors Corp.
35. AC Spark Plug Div., General Motors Corp.
36. Vickers, Inc.
37. Kolene Corp.
38. Ross Gear & Tool Co., Inc.
39. Hercules Motors Corp.
40. Hercules Motors Corp.
41. MB Manufacturing Co.
42. Allison Div., General Motors Corp.
43. Allison Div., General Motors Corp.
44. Imperial Brass Manufacturing Co.
45. Cleveland Graphite Bronze Co.
46. Timken Roller Bearing Co.
47. Marlin-Rockwell Corp.

ROOMS 1-2-3

Long Manufacturing Div., Borg-Warner Corp.
Marvel-Schebler Products Div., Borg-Warner Corp.
Mechanics Universal Joint Div., Borg-Warner Corp.
Morse Chain Co., Div. Borg-Warner Corp.
Rockford Clutch Div., Borg-Warner Corp.
Warner Automotive Div., Borg-Warner Corp.
Warner Gear Div., Borg-Warner Corp.
Wooster Div., Borg-Warner Corp.



DISPLAY HOURS:

Mon., Tues., and Wed.
9:00 A.M. to 6:00 P.M.

Thurs.
9:00 A.M. to 4:00 P.M.

SAE national meetings

September 8-11, 1958,
National Farm, Construction, and
Industrial Machinery Meeting,
Production Forum,
and Engineering Display,
Milwaukee Auditorium,
Milwaukee, Wis.

- September 29-October 4, 1958, Aeronautic Meeting, Aircraft Manufacturing Forum, and Engineering Display, The Ambassador, Los Angeles, Calif.

- October 20-23, 1958, Transportation Meeting, Lord Baltimore Hotel, Baltimore, Md.

- October 21-24, 1958, Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.

- November 5-6, 1958, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

- January 12-16, 1959, Annual Meeting, and Engineering Display, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

- March 16-18, 1959, National Passenger Car, Body and Materials Meeting, The Sheraton-Cadillac, Detroit, Mich.

- March 19-20, 1959, National Production Meeting, The Sheraton-Cadillac, Detroit, Mich.

- March 31-April 3, 1959, National Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotel Commodore, New York, New York

- June 14-19, 1959, Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

- August 10-13, 1959, National West Coast Meeting, Hotel Georgia, Vancouver, B. C., Can.

- September 14-17, 1959, National Farm, Construction, and Industrial Machinery Meeting, Production Forum, and Display, Milwaukee Auditorium, Milwaukee, Wis.

- October 5-10, 1959, National Aeronautic Meeting, Aircraft Manufacturing Forum, and Aircraft Engineering Display, The Ambassador, Los Angeles, Calif.

- October 26-28, 1959, National Transportation Meeting, La Salle Hotel, Chicago, Ill.

- October 27-28, 1959, National Diesel Engine Meeting, La Salle Hotel, Chicago, Ill.

- October 28-30, 1959, National Fuels and Lubricants Meeting, La Salle Hotel, Chicago, Ill.

Rambling . . .

THROUGH THE SECTIONS

GOOD TEST PILOTS must have a particular kind of desire — the desire to contribute to the advancement of science and engineering. The guy who says, "Show me the shiny knobs and I'll fly this thing," is not a potential test pilot. . . . A potential test pilot is the guy who can become part of a flight test team, a professional who has the desire and knowledge that he will contribute to the advancement of aviation, and who has faith in his own ability to perform test flight missions properly.
(Alvin S. White, Experimental Test pilot, North American Aviation, Inc., **SAN DIEGO SECTION** in May.)

• • •

Closing the Section year for the **WILLIAMSPORT GROUP** was Karl A. Domeisen, experimental engineer of AVCO's Lycoming Division. The speaker addressed the group on "Diesel Engines," drawing from his U.S. and European experience in the diesel engine field.

• • •

When designing a new helicopter, safety, ruggedness and economy must be prime considerations. Decisions reached by B. W. Sznycer, president of Omega Aircraft Corp., in designing a new craft, included:

Safety — two engines for autorotative landings give the pilot a chance to look for a landing spot and increase his chances of bringing the machine down in one piece.

Ruggedness — at least 750 hours between overhauls provide maximum operation during busy seasons.

Economy — two Franklin engines with turbo-superchargers give the desired 450 hp up to 10,000 ft altitude, and at the same time cost about one-half the price of one engine of double the power.
(**SYRACUSE SECTION** in March.)

The Mac Short Memorial Award of the **SOUTHERN CALIFORNIA SECTION** was presented to two California State Polytechnic College seniors. Co-authors H. Harry Mueggenburg and J. Faustino Cutti were selected for their paper on "The Design, Construction and Testing of a Centrifugal Filter."

Plague presentation, left to right, Co-winner Cutti; Mrs. Mac Short, wife of the late chief engineer of Lockheed Aircraft Corp.; Co-winner Mueggenburg; and D. K. McKinley, Section Student chairman.

April meeting of the **BALTIMORE SECTION** featured the "Free Piston Story," presented by Paul Klotsch of Ford's Scientific Laboratories. Discussion after the meeting included, l. to r., Klotsch; M. E. Ensor, 1957–58 Section chairman; O. B. Noren, Chrysler Engineering Division; F. A. Robbins, Koppers Co., Inc.; H. V. Nutt, Naval Engineering Experimental Station; and G. A. Bamford, Baltimore Transfer Co.

Three members of the **CLEVELAND SECTION** Governing Board stop to inspect a slotting machine in operation at the Lamson & Sessions Co. during the Section's plant tour in May. Left to right, Kenneth J. Sorace, 1957–58 Section Student Committee chairman; Eugene J. Manganiello, 1957–58 Section chairman; and Edwin H. Scott, 1957–58 Section treasurer. June meeting in Cleveland was the annual golf outing.

Cresons Tour Northwest

The key to Portland, Oregon — "City of Roses" — was presented to W. K. Creson during his extensive trip through the West, Northwest, and Canada in May. Above City Commissioner William Bowles (center), welcomes Creson to Portland, and 1957–58 **OREGON SECTION** Chairman C. A. Hancock (left) welcomes Creson to the Section.

VISITING oil-well drillings, lumber and plywood mills, numerous production plants, five SAE Sections, and several Student Branches — SAE President and Mrs. W. K. Creson were welcome guests throughout a recent trip through the West, Northwest and Canada.

His first trip to the **ALBERTA GROUP** and to Calgary, Alta., Canada, Creson had a close-up view of oil drills and was "amazed" at the amount of engineering required in the operations.

In Portland, Oregon, the Creson's were treated to a tour of one of the West's large lumber and plywood mills where they followed the entire procedure of milling lumber, cutting and forming plywood sheets, and the making of Presto logs and other wood products.

At the **SPOKANE-INTERMOUNTAIN SECTION,** Creson and Section officers traveled to State College of Washington for the SAE Student Paper Presentation. Speeches included "Tomorrow's Engineer" by Creson; "Fiberglass in the Automotive Industry" by Darrell Theige of State College of Washington; "Loader Swings" by Melvin Taggart of University of Idaho; "Introduction to Strain Gages" by Dennis McJunkin of WSC; and "Air Cooled Diesels" by Joe D. Wilson of University of Idaho.

• • •

First lady of SAE, Mrs. W. K. Creson, also was welcomed and honored during the trip, above she receives a bouquet at **NORTHWEST SECTION'S** annual President and Ladies Night. Participating in the presentation were, left to right, Mrs. and Mr. John Conti, Section Chairman; Mrs. Creson; E. W. Rentz, manager, SAE Western Branch Office; and W. K. Creson.

Old Timers' Night was staged at the **NORTHERN CALIFORNIA SECTION** as the Cresons made their last Section-stop. Former Section chairmen, seated, left to right, N. Buchanan, 1957–58 chairman; E. W. Rentz, manager, SAE Western Branch Office; W. K. Creson, SAE President; C. F. Becker. Standing left to right, J. A. Edgar; E. J. McLaughlin; A. G. Cattaneo; E. B. Lien; R. A. Hundley; S. E. Onorato; R. W. Goodale; W. G. Nostrand; J. E. Glidewell; and J. R. MacGregor.

The Cresons visited the **ALBERTA GROUP** on its Ladies Night of dancing and entertainment. Time-out with past & present Section Governing Board members, seated, left to right, W. H. Hannam, meetings chairman; W. R. Davis, 1957–58 Section chairman; W. K. Creson; C. H. Dawson, Section secretary. Standing, left to right, L. R. Milton, arrangements chairman; Colin MacKenzie, publicity chairman; B. Arnold Harrison, vice-chairman; and W. Fairhead, program chairman.

100+ Knock Rating Is Instrument Problem

Based on paper by

ARTHUR W. POPE, JR.
Waukesha Motor Co.

WHEN it became apparent that knock rating in the range above 100 was an instrument rather than a cylinder problem, a simplified combination mechanical ballistic and electric pickup was developed.

This new experimental pickup seemed to be a happy combination of the mechanical ballistic principles of the original Midgely bouncing pin with a modern barium titanate magnetostrictive material of such high output that no magnet or coils are required to obtain a satisfactory output signal. Fig. 1 illustrates the extreme simplicity of the device, with the barium titanate capsule mounted at the upper end, isolated from the engine heat and bearing on the upper end of the bouncing pin, which rests on a diaphragm exposed to the combustion chamber. The voltage output from this pickup is about double that of the standard ASTM pickup. It can be increased if needed by the size of the barium titanate capsule. The output signal shape differs from the standard pickup in that the high-frequency wave following the main-pressure peak is absent. The mechanical inertia of the pin probably accounts for this.

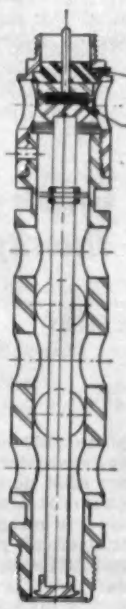


Fig. 1 — Barium titanate pickup assembly.

The output signal voltage peak from the barium titanate pickup on reference fuel and aromatic-type fuel shows the same characteristic as the standard pickup, namely that the reference fuel will knock much harder than an aromatic-type fuel which puts out the same signal strength. To correct this situation it is simply necessary to differentiate the output partially with a shunt resistance across the pickup output leads. When this is done the signal voltage from the low knocking fuel is lowered more than the voltage from the heavy knocking reference fuel. The shunt can be adjusted until the voltage output from the pickup corresponds with the audible knock intensity.

Having produced a signal strength proportioned to the audible knock intensity, all that is then required is a meter to measure the signal strength. This is in contrast to the standard rate of change of pressure signal, which might or might not show a peak proportional to the detonation intensity. The standard meter required a filter system to select the part of the signal most affected by detonation. The need of any filter is eliminated with the new mechanical electric pin, as the main signal peak is directly proportional to audible detonation. Therefore, the meter is very much simplified by completely eliminating the filter system.

Briefly, the new electromechanical detonation pickup, in conjunction with the simplified electronic meter, accomplished the following results:

1. Knock ratings that are meaningful can be made in the range above 100 octane on aromatic-type fuels.
2. Positive control is provided to permit establishing the rating level of the highly aromatic-type fuels at a point to correlate with average full-scale engine ratings.
3. The electromechanical detonation pickup is an extreme simplification of both the mechanical bouncing pin and the magnetostrictive pressure pickup. It eliminates all the adjustment variables of the old bouncing pin and the intricate metallurgical, electrical, and mechanical manufacturing details required for the magnetostrictive pickup.

(This digest is based on the 1957 Horning Memorial Lecture. The complete lecture will be published in the 1959 SAE Transactions.)

To Order SP-218 . . .
on which this article is based, see p. 6.

Single Leader Best for New Development Program

Based on secretary's report by

E. D. GIBSON
Reaction Motors, Inc.

NEW development programs must be organized from the outset under single leadership.

Such an arrangement permits coordinated effort which, in turn, allows effecting the compromises necessary to productize a research and development effort within a reasonable time and within practical dollar limitations.

The success of the program will depend on the degree of coordination between engineering, manufacturing, and quality control.

In addition to the panel secretary, others serving on the panel which developed the information in this article were: **D. C. Eaton,** Reactor Motors, Inc.; **G. T. Willey,** The Martin Co.; **J. S. Liefeld,** Marquardt Aircraft Co.; **S. W. Brown,** Bureau of Aeronautics; **C. D. Flanigen,** Avco Manufacturing Corp.; and **E. H. Boullioun,** Boeing Airplane Co.

To Order SP-323 . . .
on which this article is based, see p. 5

Three Parts Form Quality Control Cost

Based on secretary's report by

VINCENT NICHOLS
Bendix Aviation Corp.

AFTER the design of a product is completed and drawings are released, the cost of maintaining quality can be broken down into three general areas:

1. Prevention expense.
2. Control and appraisal expense.
3. Quality failure expense.

Prevention expense is the amount expended to test the material or components that go to make up the product. Its purpose is to prevent failure in the field that would not be discernable in a routine inspection or appraisal check.

Control and appraisal expense includes the cost of everything involved in the normal inspection and evaluation processes.

Quality failure expense includes scrap and rework — that is, the failure to achieve quality in a part. It also includes warranty expense which is the

money spent for service parts and labor and represents a failure of the quality guaranteed to be there by the nature of the warranty itself.

The cost of prevention, control and appraisal, and quality failure, based on what the customer will accept, is how much management has to afford to pay for quality because it must pay it to satisfy its customers.

In addition to the panel secretary, others serving on the panel which developed the information in this article were: **R. G. Fitzgibbons,** Bendix Aviation Corp.; **Les Welty,** Dodge Mfg. Corp;. **L. C. Freeman,** Whirlpool-Seegar Corp.; **Dale Lobsinger,** United Airlines Inc.; **Warren Jones,** Management Controls; **Francis Jolliffe,** Borg-Warner Corp.; and **David Van Hein,** U. S. Rubber Co.

To Order SP-322 . . . on which this article is based, see p. 5.

Fuels Aid Diesel Development

Based on talk by

D. R. JONES
California Research Corp.

(Presented before the SAE Northern California Section)

DIESEL fuels have played an important role in the dominant position diesel engines have gained in many fields, particularly heavy-duty mobile power. The absence of any serious problems with diesel fuels can be attributed to: (1) production of consistently high quality fuels with close manufacturing quality control, (2) properties designed to give optimum performance and long, trouble-free life, and (3) careful handling in distribution and by the customer.

Most diesel fuels used in high-speed, automotive-type engines are distilled directly from special crude oils that have been segregated because of certain desirable properties. The fuels distilled from these crudes are generally given additional treatment to improve quality before final blending.

Power, economy, and exhaust smoke of diesel engines are affected by three fuel properties: cetane number, viscosity, and heating value. In many engines, increased cetane number adversely affects high load performance. On the other hand, high cetane numbers are beneficial under cold-starting and light-load operating conditions. Fuel viscosity affects atomization and dispersion of fuel droplets in the combustion chamber and thus has an important effect on performance. Other things being equal, power output varies directly and fuel consumption inversely with the volumetric heating value of diesel fuel. Heating value is closely related to the API gravity and midboiling point of diesel fuel. Wear and deposits in a diesel engine are influenced by several other fuel properties, including sulfur, ash, and carbon residue contents. Flash point and pour point are important properties from the standpoint of fuel handling and safety.

Additives may be used to add further desirable properties to diesel fuels. Types of additives being used by refiners include cetane improvers, antifilter plugging dispersants (used mainly in catalytically cracked "economy" diesel fuels), rust inhibitors, and detergents. A detergent additive prevents deposits from forming on critical injector parts, thus maintaining satisfactory combustion and economy.

Dependable Lubes Needed for Machine Tools

Based on paper by

B. M. DUNHAM
Sun Oil Co.

(Reported by Gilbert K. Brower, SAE Chicago Section)

THE design and formulation of modern lubricants have kept pace with the improvements in design of modern integrated machinery. Actually, in so far as types of lubricants are concerned, they are no different for integrated machines than for single units. Functional properties of modern lubricants have been greatly improved upon, however, to offer better insurance and multi-use characteristics to reduce inventories. Some of these properties are: better stability, antirust protection, anticorrosion protection, improved film strength, better antiwear characteristics, and superior natural cleansing action. The general theme is "dependability." Users are becoming ever more cognizant that the most expensive initial oil cost is quite insignificant as related to machine cost and they just cannot afford to take chances with lubricants of questionable quality.

Table 1 shows a plan for simplified selection of lubricants for machine tools. This plan allows for a minimum of seven oils and two greases to accommodate the majority of lubricant applications. Such a plan would be ideal; however, due to special requirements it can seldom be practiced in large plants. A study of the lubricant specifications adopted by the large automotive companies indicates that they require over 70 products exclusive of cutting fluids to accommodate all plant lubrication requirements adequately. With the advent of multi-use lubricants, their numbers will gradually be reduced.

Table 1 — General Recommendations for Machine Tools

Parts To Be Lubricated	Grade — Approximate Viscosity, SSU at 100 F
Machine, general hand, mechanical, splash or circulating systems:	
Low viscosity	150-200
Medium viscosity	300
High viscosity	500
Gears (enclosed):	
Light duty	500 to 900 (SAE 90)
Heavy duty (including worm gears)	2500 (SAE 140) e-p
Hydraulic systems:	
Low Viscosity	150
Medium viscosity	300
Spindles:	
High speed (oil)	50-150
Low speed (oil)	100-300
Grease lubricated	N.L.G.I. No. 1
Ways:	
Average loading	300 to 400 (special oiliness and e-p qualities)
Abnormal loading	1000 (special oiliness and e-p qualities)
Grease lubrication	
Normal temperatures	Lime-base grease N.L.G.I. No. 1
High temperatures	Soda-base or lithium-base grease N.L.G.I. No. 2

To Order Paper No. S100 . . . on which this article is based, see p. 5.

When It's Cold Outside— Watch that Oil Viscosity!

Based on paper by

THEODORE W. SELBY
General Motors Research Staff

(Reported by Gilbert K. Brower SAE Chicago Section)

MEASURED viscosities at 2000 sec^{-1} give significantly better correlation with cranking experience than do two other methods of determining low-temperature viscosities studied: a recently developed analytic technique of prediction and the often used ASTM chart method of extrapolation.

Since measured viscosities take into account the low-temperature phenomenon of polymer gelation, it seems that such phenomena influence cranking

continued on page 111

New Pressure Pickup Saves Wind Tunnel Test Time

(Presented before SAE San Diego Section)

Based on paper by

J. F. L. ALDRICH and S. TRIPOLI

Douglas Aircraft Co., Inc.

BLOW-DOWN supersonic wind tunnel operators can save valuable testing time if pressure pickups are designed to give a maximum response time. The time lag between pressure applied at the pickup hole in the model and the final level of the liquid in the manometer is usually large enough that the test engineer will accept some measuring error to save tunnel running time.

Two typical types of pressure change that produce reading errors are the step and ramp pressure gradients. These are illustrated in Fig. 1. Fig. 2 gives a schematic of a pressure pickup. The change in instrument volume, V_d, will be zero for a pressure-transducer instrument.

The time for an instrument to reach a relative error, ε, in per cent, for the step pressure change is:

$$t = \frac{0.111\mu(l_e/d_e)^2}{P_f}(F_v + F_d)$$

where:

$$F_v = \left[1 + \frac{V_e}{V_i}\left(1 + \frac{1}{K}\right) + \frac{2}{K}\frac{V_m}{V_i}\right] ln\,\frac{(\varepsilon + 2/\delta + 2)}{\varepsilon/\delta}$$

$$F_d = \frac{2}{K}\frac{V_d}{V_i}\,ln\left[\left(\frac{\varepsilon+2}{\delta+2}\right)^{\frac{\delta+2}{\delta}}\left(\frac{\delta}{\varepsilon}\right)^{\frac{\delta-1}{\delta}}\right]$$

P_f = Final pressure of step change, psi

μ = Viscosity in air, 3.8×10^{-7} slugs per ft-sec at 80 F

$$\frac{1}{K} = 1 + \frac{l_a/l_i}{(d_a/d_i)^4}$$

A conservative measure of the maximum error, P, of a ramp pressure change is $\Delta P = 10\,R$. R is the response function of the system and is defined by:

$$R = \frac{dP/dt\,10^{-4}(\pi/4)}{P_i}\left(\frac{l_i}{100 d_i}\right)^4 \left(\frac{l_e}{l_i}\right)\left(1 + \frac{V_e}{V_i} + \frac{V_m}{V_i}\right)$$

where:

$$l_e = l_i + l_a$$

$$V = 0$$

The step-type lag time increases linearly with tube length, inversely to the fourth power with tube diameter, and inversely with the final pressure. The equations also show that there is an optimum ratio of tube diameters, giving a minimum lag time. A chart of lag time for different combinations of variables is given in Fig. 3.

To Order Paper No. S89 . . . on which this article is based, see p. 5.

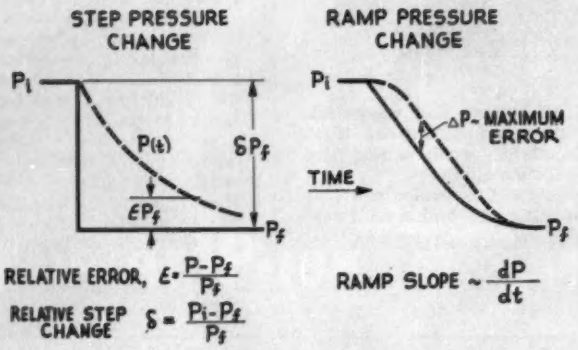


Fig. 1 — Two common types of pressure change in wind tunnel testing are step and ramp. The first is typical of the tunnel starting up or a change in angle of attach of the model. The second occurs when the tunnel is speeded up or slowed down. The solid lines are the pressures measured at the pickup orifice on the model. Dotted lines are the pressure at the measuring device.

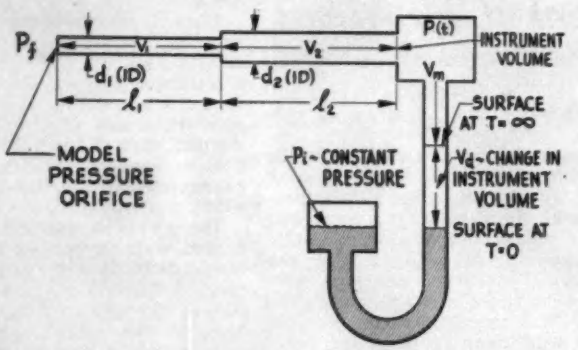


Fig. 2 — Pressure pickups often have two diameters of hose connecting them to the instrument. Correct diameter ratio can improve the lag time.

Fig. 3 — Effect on lag time for a step pressure change can be seriously affected by a change in the geometry of the pressure system.

CASE	TUBE No. 1		TUBE No. 2		INSTRUMENT VOLUME		FINAL PRESS.	δ	ϵ	EFFECT SHOWN	TIME (SEC.)
	l_1 (IN.)	d_1 (IN.)	l_2 (IN.)	d_2 (IN.)	V_m (IN^3)	V_d (IN^3)	P_f (p.s.i.)				
1	60	.03	0	—	0.3	0	7.35	1	.01	BASIC	1.5
2	600	.03	0	—	0.3	0	7.35	1	.01	LENGTH	23
3	600	.06	0	—	0.3	0	7.35	1	.01	DIAMETER	3.3
4	60	.03	540	(OPT.) .054	0.3	0	7.35	1	.01	OPTIMUM	11
5	60	.06	540	(OPT.) .09	0.3	0	7.35	1	.01	d_2	2.0
6	60	.06	540	(OPT.) .10	6.0	-0.3	7.35	1	.01	INSTRUMENT VOLUME	2.4
7	60	.06	540	(OPT.) .10	6.0	-0.5	1.47	9	.01	FINAL PRESSURE	14
8	60	.06	540	(OPT.) .10	6.0	-0.5	1.47	9	.05	ALLOWABLE ERROR	10

AERO 162

Vendee-Vendor Clarity Helps Improve Quality

Based on secretary's report by

C. E. REID
Republic Aviation Corp.

MUTUAL vendee and vendor understanding and agreement will help prevent quality problems and also improve product quality.

Some steps the vendee can take toward making this end a reality are:

1. Make sure the vendor can do the job. Make sure he has the proper processing and gaging equipment before awarding him a contract.
2. Tell the vendor exactly what is required and how it will be checked.
3. Make sure the vendor's inspection equipment is in close agreement with the equipment at incoming inspection.
4. Through a close association with the vendor, show him how the nature of the work requires quality to be closely controlled. Have the vendor realize that he is expected to use some satisfactory quality control method and, if necessary, that the company is willing to help him in this effort.
5. Convince the vendor of the desirability of having your own personnel visit his plant when problems arise. The vendor should appreciate that such visits are costly for your company and will be suggested only when it is believed the meeting will be of mutual benefit.
6. Invite the vendor to visit your plant so that he can see first-hand how his work is checked and how his part is used.
7. Provide any needed instruction in quality control for vendors.

In addition to the panel secretary, others serving on the panel which developed the information in this article were: **Ralph Wheeler**, Cessna Aircraft Co.; **Frank Griffith**, Trans World Airlines, Inc; **Earl Champion**, Pratt & Whitney Aircraft; and **Glenn Hackett**, Thompson Products, Inc.

To Order SP-323 . . .
on which this article is based, see p. 6.

Operations Research Aids in Birth of New Products

Based on secretary's report by

K. FOREMAN
Fairchild Engine & Airplane Corp.

THE prediction of new business or the recommendation of a new line of products could result from a linear programming study, which is a frequently used technique of operations research. A market forecast is made after the background statistics associated with business changes are analyzed. The new product concept is assigned to the design department for birth as a practical article.

Producibility engineers help the designers evolve an item practical to be manufactured at General Electric. Differences between design requirements and the ability to manufacture are compromised by high-echelon management who are guaranteed by the process development group of a certain net profit each year.

The GE approach is to split the coverage into two teams, a development prototype group and a production group, who work separately with the design engineers.

At Pratt & Whitney, a service organization called the advanced tooling group is assigned to the advanced engineering department to assist in keeping the design a practical one. A methods and equipment group also exists which concentrates on manufacturing techniques, process development, and standardization.

A third method, used by Martin, is the formation of a manufacturing research and development group encompassing three production requirements areas.

The first attends to the current product-line problems, and seeks out expeditious solutions.

Advanced process planners are assigned to current engineering development programs which represent production work of the near future. The project manager has responsibility for compromising differences of opinion which may arise.

The advanced planners are not concerned with tooling requirements but insure that by the time a design is ready for manufacture, 3 to 6 months hence, the way of fabricating is not obsolete. Since this advanced planning is done continuously, the detailed process sheet writing is never faced with other than routine or well-defined operations. (Boeing goes one step further and orders special tooling or equipment in advance when it appears necessary to their advanced planners.)

Manufacturing capability and problems associated with distant future work (5–10 yr) are reviewed by a group which is tied in with the materials laboratory. Specific processes are not developed.

In addition to the panel secretary, others serving on the panel which developed the information in this article were: **R. A. Gross**, Fairchild Engine & Airplane Corp.; **E. F. Gibian**, Thompson Products, Inc.; **L. E. Laux**, The Martin Co.; **J. Morgan**, Cincinnati Milling Machine Co.; **K. W. Stalker**, General Electric Co.; and **F. Fennessy**, United Aircraft Corp.

To Order SP-323 . . .
on which this article is based, see p. 6.

Shorter Delivery Cycle Increases Vendor Costs

Based on secretary's report by

C. E. REID
Republic Aviation Corp.

SHORTER production runs for the vendor create inefficiencies in his production; therefore his costs go up.

Improper planning behind the requirements instigates voluminous purchases. This generates more material receipts, greater material handling, more invoices to be paid, and a greater amount of paper work in general.

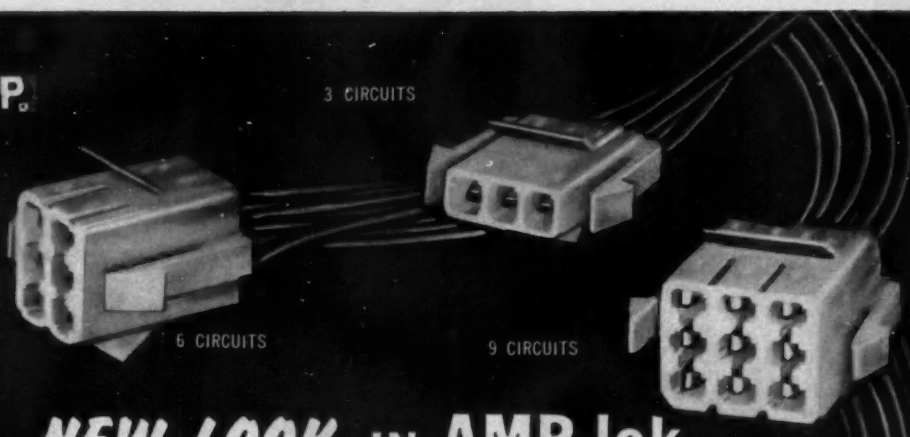
Shortening the delivery cycle tends to slash inventory but it is cause for purchasing to buy from "hand to mouth", pay premium prices, spend more time and money in following up and expediting. This time should be applied to closer analytical buying.

Proper analysis and control of inventory will help control delivery-cycle time. The delivery cycle can be shortened to an advantage cost-wise on high-cost items. On common materials of low cost extend the delivery-cycle time. The establishment of economical order quantities is a must.

In addition to the panel secretary, others serving on the panel which developed the information in this article were: **Ralph Wheeler**, Cessna Aircraft Co.; **Frank Griffith**, Trans World Airlines, Inc.; **Earl Champion**, Pratt & Whitney Aircraft; and **Glenn Hackett**, Thompson Products, Inc.

To Order SP-323 . . .
on which this article is based, see p. 6.

AMP



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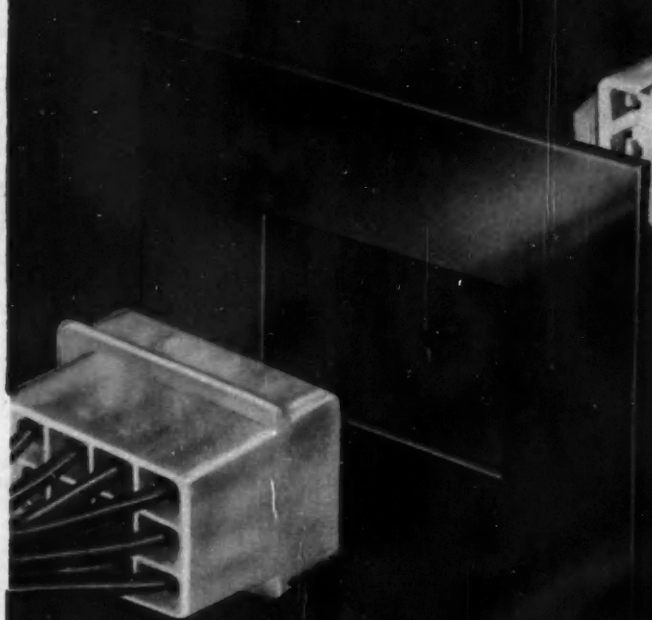

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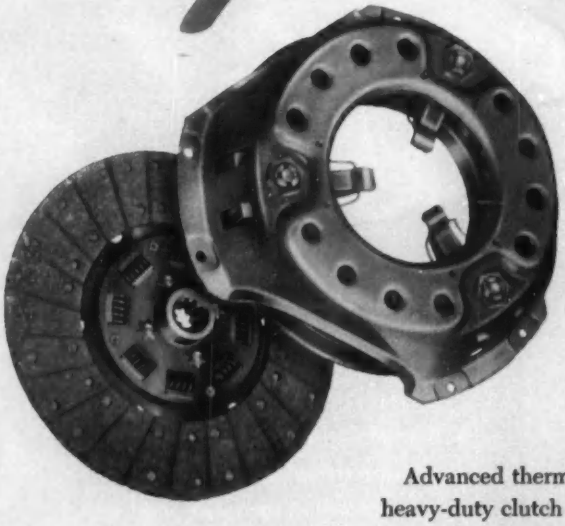
Lowers fuel, maintenance and replacement costs per truck mile!

Lipe DIRECT PRESSURE CLUTCH



Vital component in today's most economical system of power transmission, the Lipe DPB Heavy-Duty Clutch costs less at the start... materially reduces the competitive selling price of the vehicle . . . and affords substantial savings in over-all truck-operating costs per mile.

Other elements of the power-train contribute to these savings, but the Lipe DPB Heavy-Duty Clutch absorbs the greatest shocks and fiercest friction, dissipates the most heat, and by its simplicity, direct drive, easy adjustment and replacement-exchange, keeps the vehicle rolling with less cost for fuel, brake relining, oil replenishment and repair. Its worth in highway safety and preventative brake maintenance alone places it far in advance of costlier and more complicated drive components.

Advanced thermodynamic design and positive air circulation add up to a heavy-duty clutch of uncomplicated design with few moving parts. In short, it's a clutch with a low maintenance cost that matches both its low first cost and greatly lower truck-mile costs of operation.

● Lipe DPB clutches now available in 12", 13", 14", 15" single and two plate models. Write for engineering data sheets on the sizes which interest you.

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.

MANUFACTURERS OF AUTOMATIC CLUTCHES AND MACHINE TOOLS

continued from page 106

efforts. This observation was supported by the statistical evidence of a closer agreement between the measured and predicted correlations of the PAMA (polyalkylmethacrylate-containing) test fluid, which develops little polymer structure at low temperatures.

Predicted viscosities of polymer-containing fluids were indicated to correlate better with cranking speed than extrapolated viscosities, especially for the PAMA fluids, which in viscometric analysis showed little polymer gelation, as just mentioned.

The statistical analysis of the data showed, among other things, that the data could be treated by an equation of the form:

$$M = c(\mu N)^b$$

where:

M = Torque applied to rotate journal at a given speed
c = Constant
μ = Viscosity
N = Speed of journal
b = Constant, close to 0.5

These results support previous measurements by other investigators.

To Order Paper No. S104 . . . on which this article is based, see p. 5.

Self-Development Process Key to Higher Production

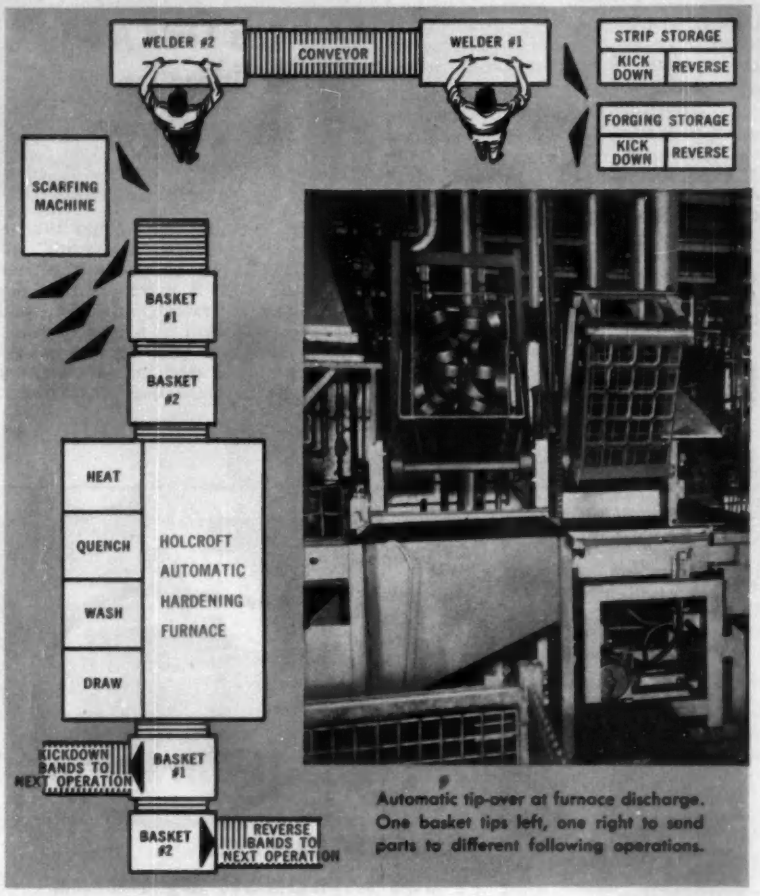
Based on secretary's report by

WALTER J. CAMPBELL
General Electric Co.

POINTS to consider in improving productivity through releasing gerater human potential are:

1. All individual development is self-development — no one can develop others. Initiative for development must come from within the individual.
2. No employer owes an employee the opportunity for self-development. He should seek the opportunity himself in hopes of advancement.
3. Since business finds it a matter of preservation to provide such opportunities, they should consider the expenses as part of the wage bill and should also look for a direct and measurable return on the investment.
4. Everyone does not seek advancement. Therefore, programs aimed at groups are wasteful.
5. Only qualified volunteers should be given opportunities.
6. Unless an immediate plan is visible for using an individuals' new capacities, programs may create bad morale, rather than good.
7. Encouraging each individual employee to develop and use his highest

continued



Automatic tip-over at furnace discharge. One basket tips left, one right to send parts to different following operations.

Fully automatic hardening furnace by HOLCROFT requires no operator...

Sorts hardened parts automatically

In this transmission parts line two welding operations, scarfing, hardening and two sorting operations are handled by just two welding operators . . and a Holcroft automatic hardening furnace. The operator at the second welding station distributes his output into two baskets, one for kickdown bands and one for reverse bands. The Holcroft furnace collects both baskets, heat treats the parts and *automatically* sorts them onto two conveyors which carry them to separate additional operations, all without rehandling of the parts or attention of any kind.

Holcroft engineered and built eight of the furnaces in this modern automotive transmission plant and every one of them shows the same leadership in design concept and quality of construction. The result of this leadership is clear; top quality production, lowest possible operating costs, long, trouble-free life. These are the true measure of heat treating economy. Next time you have a heat treating problem, call on Holcroft engineers to show you how to get truly economical production.

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PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE
CHICAGO, ILL. • CLEVELAND, OHIO • HARTFORD, CONN. • HOUSTON, TEXAS • PHILA., PA.
CANADA: Walker Metal Products, Ltd., Windsor, Ontario

talents, where they apply, to the benefit of the business enterprise is one of the greatest challenges facing managers today.

In addition to the panel secretary, serving on the panel which developed the information in this article were: **J. Penn Rutherfoord,** General Electric Co.; **Glenn Gilman,** Lockheed Aircraft Corp.; **John Van Lonkhuyzen,** Bell Aircraft Corp.; **Robert Hauserman,** Thompson Products, Inc.; **Dugald Black,** Bendix Aviation Corp.; and **D. F. Pratt,** Cincinnati Milling Machine Co.

To Order SP-323 . . . on which this article is based, see p. 5.

Computers Could Aid Aircraft Utilization

Based on paper by

W. A. PAGE
Douglas Aircraft Co., Inc.

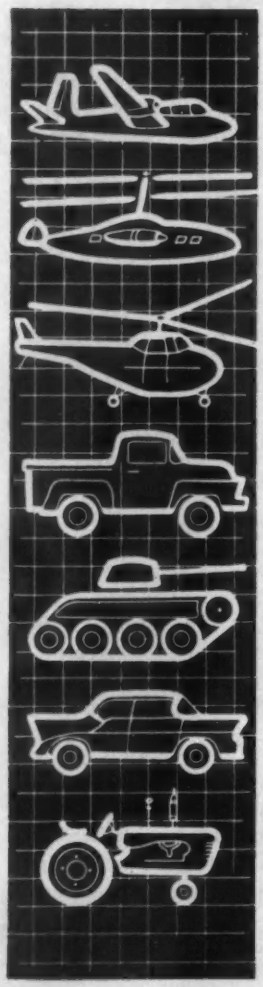
USE of computer aids could take a great deal of the "dog-work" off the shoulders of experienced airline personnel. And it is certain that operational and systems analysis could improve utilization in a host of ways.

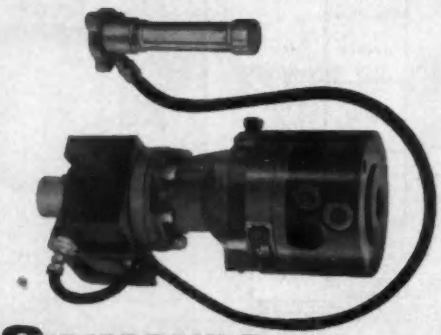
It seems to be entirely practicable, for example, to feed into a computer as controls, construction of schedules, with limited departure times, "competition factors," and "human element" factors. Other possibilities are:

- Determination of optimum location of line maintenance stations, based upon certain probability factors affecting aircraft availability, punctual arrival times, and the like.
- Optimum location for on-line staff from both maintenance and traffic viewpoints.
- Flow and location of spare parts; of purchasing, and inventory control.

Savings can always be made. That's the overriding point of importance. It's even more important to the airline business to see that they are made wherever possible because profit margins are so slim in contrast with other vast undertakings. The starting point is to assume with 99% certainty that savings can be made, then make prudent use of every intellectual tool of modern science to see that they are made.

As aviation moves with great rapidity into a sphere of larger operations, with larger, faster airplanes carrying an ever greater number of passengers and volume of freight, profit margins must not be, and cannot be, enhanced by an extension of outward boundaries alone. They must come from a proportional contraction of overhead as well. Enlarging the scale of operations can create a natural breeding ground for waste of money and effort unless the scientific advances represented by new equipment are matched by advances in imaginative use of modern methods of control.





SIMMONDS

Fuel Injection Systems In Full Production for Gasoline Engines

After several years of rigorous tests under extreme conditions of weather and environment, the Simmonds SU Fuel Injection System has been put into full production for U. S. Ordnance engines.

The System is being adapted to engines in all horsepower ranges for use in passenger cars, trucks, buses, marine and farm equipment, earth and snow moving equipment.

The Simmonds SU Fuel Injection System is a multiple point, low-pressure, timed speed-density injection system offering these definite advantages: it overcomes major icing problems; it improves cold starts; it eliminates the need of hot-spots and pre-heaters with a resulting increase in power output; it compensates for variations in barometric pressure, altitude and intake air temperature. The System also provides improved fuel distribution resulting in better cylinder head cooling – its operation is unaffected by engine attitude.

Detailed information on SU Fuel Injection Systems is now available. Write on your company letterhead for literature.

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Lubrication of Railway Journal Roller Bearings

Based on paper by

P. C. PATERSON
Railway Division, Timken Roller Bearing Co.

(Reported by Gilbert K. Brower
SAE Chicago Section)

THE grade of oil used in oil lubricated journal roller bearing boxes must conform to AAR Specification M-906 for New Car Oil, preferably all year grade. Oil lubricated journal roller bearings on passenger train equipment cars must be checked and lubricated every 30 days.

Oil lubricated journal roller bearings on freight cars must be checked and lubricated within one year. Some of the early installations of housing-type roller bearing assemblies on freight cars were lubricated with oil.

The operation of freight cars in general interchange service presents problems not ordinarily experienced with passenger cars or diesel locomotives. For example, freight cars may remain away from the owning line for months

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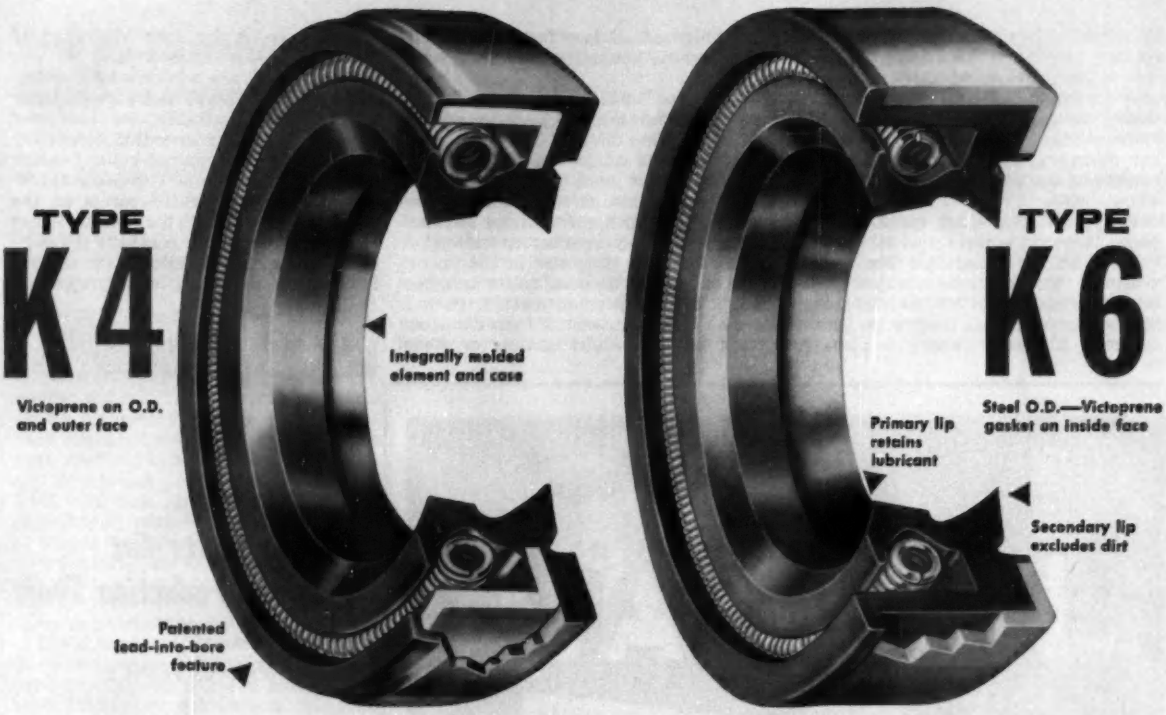

Newest design for compact dual-lip sealing

Two types . . . as narrow as ¼ inch

In Type K4 Victoprene oil seal and its variant, Type K6, Victor offers a highly improved version of compound element shaft sealing. The two types accommodate varying installation and bore sealing needs, yet provide identical shaft sealing efficiency in the smallest housing space.

Check the design features. See how these seals can enhance your specifications for all types of machinery or automotive applications. You'll like their moderate price, too—and fast availability in all standard sizes! See your Victor Oil Seal Catalog No. 305.

DUAL SEALING SURFACES —Inner lip designed for maximum fluid retention. Outer lip excludes foreign matter or confines a secondary lubricant.

VICTOPRENE ELEMENT —Developed of improved Buna N synthetic rubber for balanced resistance to lubricants, heat, and age deterioration.

PRE-LUBRICATION CAVITY between lips provides for permanent lubrication on installation. Reduces frictional drag; extends seal life.

SPACE-SAVING NARROW WIDTH — Patented one-piece, integrally molded element and case construction permits most compact seal housing.

POSITIVE SPRING LOCATION —Molded groove in sealing element holds garter spring in proper place to keep uniform pressure on shaft.

POSITIVE BORE SEALING —*Type K4* has bonded-to-case Victoprene on O.D. and outer face. Patented lead-in feature aligns seal for easy installation. *Type K6*, for metal-to-metal installations, has steel O.D., with integral gasket on inside face for bottom of bore seal.

TYPICAL APPLICATIONS—Wheel bearing seals on automotive vehicles, farm and road machinery, etc.; crankshaft; pinion; automotive transmission (rear extension housings); speed reducers; winches, etc.

K4 and K6 seals supplied without spring where it is not required

Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill.
Canadian Plant: St. Thomas, Ont.

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OIL SEALS • GASKETS • PACKINGS • MECHANICAL SEALS

Victor Oil Seal Engineering Catalog No. 305, sent free on request. No designer should be without it.

or years. They may operate for long periods without attention, and are subject to long periods of idleness at ports and terminals, due to seasonal shutdowns on the loading of coal and ore.

They may also operate over rotary car dumpers, and are often loaded in remote areas, as for example, on pulpwood cars.

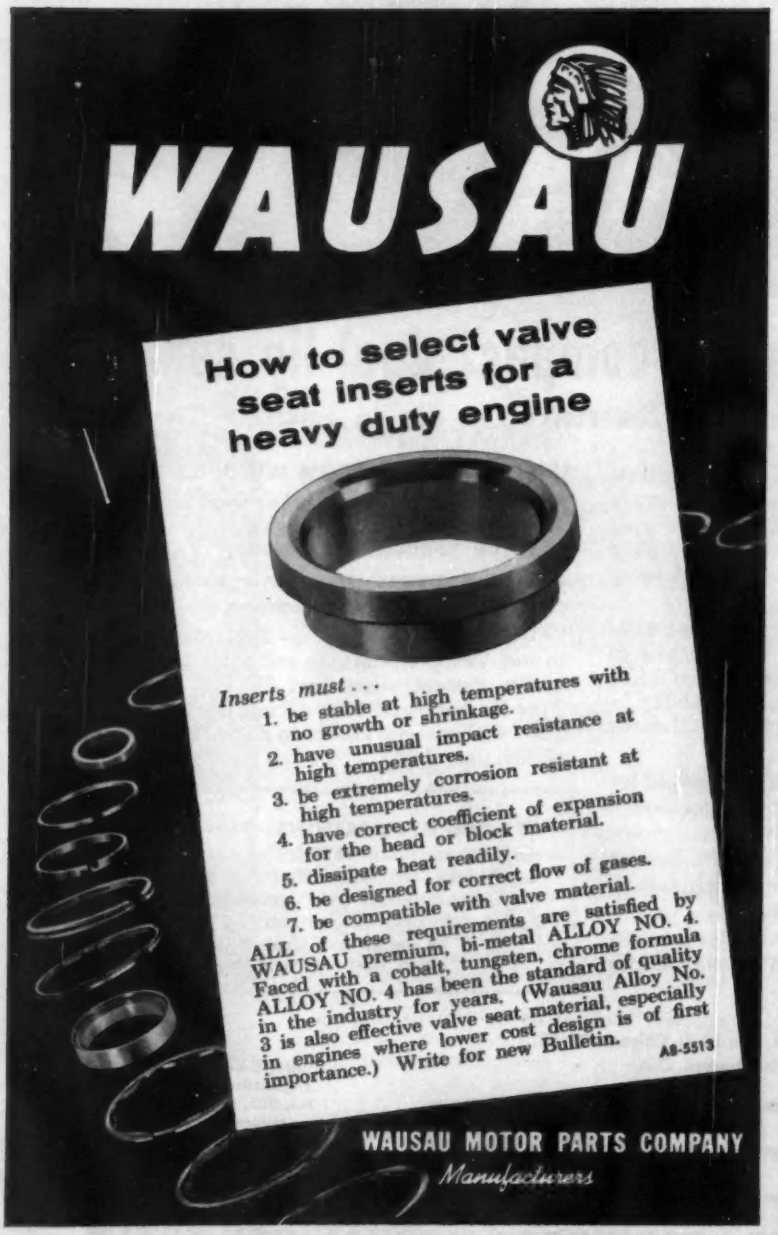
For such operating conditions as these, it would appear that oil lubrication would be unsuitable for several reasons. For example the protective oil film might drain off the surfaces of the rolling elements during periods of seasonal idleness. There is also the possibility of oil loss from the enclosures during operation over rotary car dumpers.

Optimum lubrication demands the use of a minimum quantity of the lightest bodied oil that can be successfully retained in the bearing. These demands must yield to practical operating conditions of load, speed, temperature, and other conditions encountered in railway bearing operation.

The ultimate objective in the operation of railway journal roller bearings is to schedule relubrication periods with other phases of maintenance work, such as wheel turning or wheel renewal, as in the case of passenger cars and diesel locomotives.

Freight cars are scheduled for cleaning of the AB brake valve every three years. It is desirable, for economic reasons, that any specified relubrication attention to journal roller bearing assemblies be done at this same three-year interval, while the car is on the light repair track for brake valve cleaning, and where centralized facilities can be made available for the relubrication operation on a production basis.

To Order Paper No. S99 . . .
on which this article is based, see p. 5.


WAUSAU
How to select valve seat inserts for a heavy duty engine
Inserts must . . .
1. be stable at high temperatures with no growth or shrinkage.
2. have unusual impact resistance at high temperatures.
3. be extremely corrosion resistant at high temperatures.
4. have correct coefficient of expansion for the head or block material.
5. dissipate heat readily.
6. be designed for correct flow of gases.
7. be compatible with valve material.
ALL of these requirements are satisfied by WAUSAU premium, bi-metal ALLOY NO. 4. Faced with a cobalt, tungsten, chrome formula ALLOY NO. 4 has been the standard of quality in the industry for years. (Wausau Alloy No. 3 is also effective valve seat material, especially in engines where lower cost design is of first importance.) Write for new Bulletin.
A8-5513
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Matador Costs Cut By Using Production Team

Based on paper by

WALTER PRINCE
Martin Co.

THE cost of the Martin Matador is constantly being cut by a team of experts from the engineering, tooling, manufacturing, and quality control departments. The missile is manufactured by sections, with "master tools" used to assure interchangeability. This team has already come up with cost-saving techniques for building the structure. Some examples are:

- Stressed skin cylindrical center section. Forming of the skin and doors in it are simple roll operations. Many details such as stringers and clips are eliminated.
- Stressed skin conical aft section and aft nose section.
- 24 bolts to splice the seven sections of the missile together prior to its final system test. The bolts are in simple tension.
- Large forgings and permanent mold castings used instead of built-up parts. This gives less detail and better dimensional control of parts such as: wings (forgings), engine rings (castings), bomb support (casting), stabilizer (casting), jato thrust fitting (forging).
- Relaxed tolerances on smoothness, flushness, and skin gaps since the missile is expendable.
- Spotwelding, automatic riveting, and automatic drilling used where possible to keep labor costs down.
- 40% of the missile is honeycomb construction because of the savings in producing this type of structure. Some examples are: wing panels, stabilizer, fin leading edge, airscoop intake duct, fuel tank floors, bulkheads, and gyro shelf.

To Order Paper No. 448 . . .
on which this article is based, see p. 5.

Good Oil Formulation Helps Save Octane Numbers

Based on paper by

M. L. KALINOWSKI, L. D. LACROIX, and R. A. NEJDL
Standard Oil Co. (Ind.)

(Reported by Gilbert K. Brower
SAE Chicago Section)

MOTOR oils contribute to combustion-chamber deposits and therefore to octane-requirement increase (ORI) and surface ignition. An investigation of the separate components of motor oils in laboratory engines showed that base oils add the largest increment to ORI, viscosity index improvers add less, and detergents and inhibitors add the least. Surface ignition is reduced by phosphorus, barium, calcium, and zinc — elements commonly found in motor oil additives. Phosphorus is especially effective; all tested additives containing it were equally effective at the same concentration of phosphorus.

The components chosen for a motor oil determine how much it will contribute to ORI and surface ignition. A good choice of base stock, viscosity index improver, and detergent for an SAE 10W-30 oil gives an ORI 6 octane numbers lower than a poor choice. Similarly, choosing phosphorus-containing detergents and inhibitors reduces octanes needed to suppress surface ignition as much as 14 units. Good formulation of motor oils can do much to save costly octane numbers.

To Order Paper No. S102 . . . on which this article is based, see p. 5.

Refrigeration Users Suggest Improvements

Based on paper by

C. P. HOFFMAN, JR.
American Trucking Associations

OPERATORS who make their living transporting perishable commodities have made these trenchant comments on the design and performance of refrigeration units in reply to a questionnaire:

1. Hard-faced valves and seats should be standard equipment.

2. Compression chamber should be designed so that lead deposits won't prevent the piston from reaching top dead center.

3. Engine should have an oil capacity of at least 1 pt per hp. We've found 5-qt crankcases on 10-hp engines give longer engine life than standard 3-qt crankcases on some 8- and 10-hp engines. The engine runs longer between oil changes and oil consumption is less critical.

4. The heavy-duty oil filter with replacement element is the best investment on small enignes. Provision for mounting and hooking up a filter is often lacking. Adding an oil filter has enabled the operator to run 100–200 hr between oil changes where the manufacturer's recommendations are for 15 hr. In some cases, the period between major overhauls has tripled.

5. Air cleaners are too small, require too frequent attention, and are inadequate for refrigeration duty. A man-sized cleaner can and will increase engine life.

6. Small engines lack adequate fuel filters and few units have any filter. Why not a ceramic-type, replaceable element to eliminate costly carburetor maintenance?

7. Very few small engines have adequate flywheel effect for smooth running. Adding 25 lb of flywheel to an average 10-hp, 2-cyl engine will make it run more smoothly. Stopping vibration eliminates line breakage and prevents fatigue and failure of the unit casing structure. Adding 25 lb of fly-

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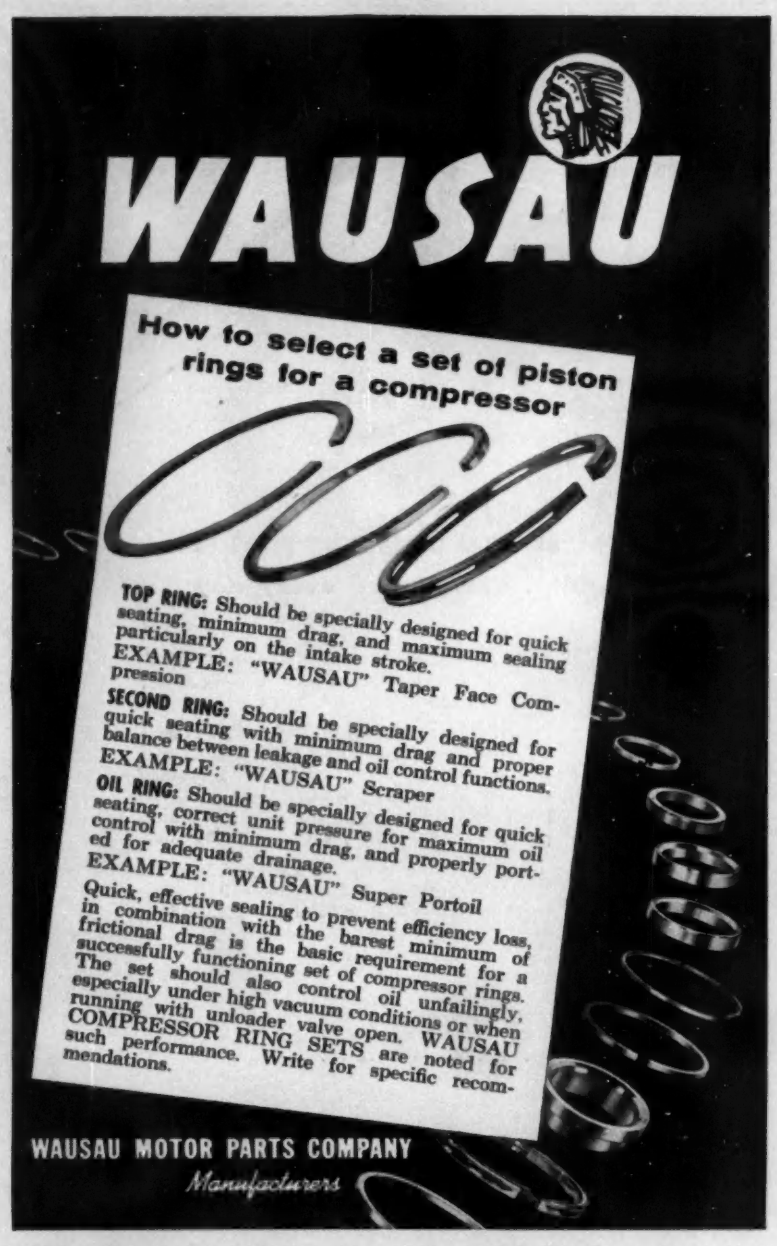
WAUSAU
How to select a set of piston rings for a compressor
TOP RING: Should be specially designed for quick seating, minimum drag, and maximum sealing particularly on the intake stroke.
EXAMPLE: "WAUSAU" Taper Face Compression
SECOND RING: Should be specially designed for quick seating with minimum drag and proper balance between leakage and oil control functions.
EXAMPLE: "WAUSAU" Scraper
OIL RING: Should be specially designed for quick seating, correct unit pressure for maximum oil control with minimum drag, and properly ported for adequate drainage.
EXAMPLE: "WAUSAU" Super Portoil
Quick, effective sealing to prevent efficiency loss, in combination with the barest minimum of frictional drag is the basic requirement for a successfully functioning set of compressor rings. The set should also control oil unfailingly, especially under high vacuum conditions or when running with unloader valve open. WAUSAU COMPRESSOR RING SETS are noted for such performance. Write for specific recommendations.
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wheel saves 25 lb of metal in the casing structure.

8. Manufacturers should provide for easy installation of low oil pressure safety cutout switches and encourage their use. A $2 switch can save a $300 overhaul.

9. Operating speed should be cut from 2400–2800 rpm to about 1800 rpm in the interest of increasing engine life.

10. Better engine accessibility would facilitate economical preventive maintenance.

To Order Paper No. 58F . . . on which this article is based, see p. 5.

Refrigeration Units Need Better Engines

Based on paper by

L. S. PFOST
Continental Motors Corp

ENGINES to power mobile refrigeration units must be able to maintain proper engine operating temperatures with ambient temperatures ranging from –40 to +130 F. And they should be capable of running without attention continuously for long periods — even under idle, no-load conditions.

Maximum power requirements for extreme conditions should be about 60% of the maximum engine capacity. If an engine is selected on that basis there will be a margin for the unforeseen, for emergency service and high altitudes.

Here are six general requirements for refrigeration unit engines:

1. Extreme dependability.
2. Long life — to survive continuous duty.
3. Minimum maintenance and servicing.
4. Simplicity and accessibility for servicing.
5. Compactness — space is at a premium.
6. Minimum noise and smoke levels.

To Order Paper No. 58C . . . on which this article is based, see p. 5.

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every hour, every heat, every day

Small ferrous alloy castings, electrically melted, and produced in high volume, have been our business since 1946.

But, in every instance, customers' needs have been unusual—involving controls to such exacting specifications that we could not rely upon ordinary foundry practices. At every critical point in the process, our own "technical policemen" are on duty every operating hour.

These manufacturing controls supplement our laboratory practice, and they make it possible to maintain the exacting customer specifications in high volume.

Suppliers of critical component castings to the automotive, aircraft, hydraulic, and special machine industries since 1946.

ENGINEERING CASTINGS, INC.
MARSHALL, MICHIGAN

Designing an Engine To Power Refrigeration

Based on paper by

DAVID W. ONAN, II
D. W. Onan & Sons, Inc.

LONGER life, more horsepower per pound, and lower cost per Btu of cooling — these are the objectives in designing better powerplants for mobile refrigeration units.

Engines should have stellite-faced valves and seats, valve rotators, heavy-duty bearings (aluminum), full-pressure lubrication, and a substantial overload factor built into each part. Few of these items are found in the average small engine.

OHV engines are most efficient and take less maintenance than L-heads. They are more expensive for a given displacement, but not necessarily in dollars per horsepower. They may be run continuously at higher speeds than the L-head and have a higher thermal efficiency. Moreover, they require less frequent carbon and lead removal and they consume less oil.

Another improvement would be to combine engine and refrigeration compressor. The directly connected, engine-compressor package needs no coupling or belts which require maintenance. The package would have fewer parts than two separate units. The compressor has no bearings since its crank throw is connected directly to the engine crankshaft. One seal keeps refrigerant and compressor oil away from the engine oil.

The engine and compressor would be matched to each other in capacity, take up little more space than the en-

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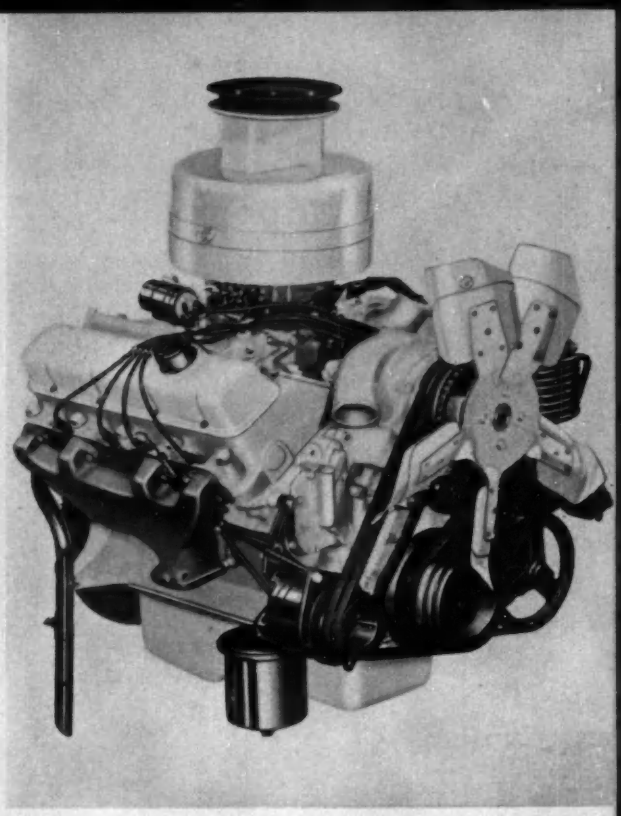

HYPALON® ignition harness designed for fewer repairs on new Ford commercial engine

To power its new heavy-duty trucks, the Ford Motor Company has developed a new engine which is designed throughout to operate longer with minimum repairs. In keeping with this objective, Ford engineers specified HYPALON-jacketed ignition wire. Because of its increased resistance to under-hood conditions, HYPALON is expected to significantly reduce maintenance and replacement costs.

HYPALON jacketing is being used mainly because Ford succeeded in obtaining higher horsepower from a compact engine. This created the problem of higher under-hood temperatures and their deteriorating effects on elastomeric parts. However, Ford engineers knew they had solved it when HYPALON synthetic rubber successfully met a heat-aging requirement of 5 days at 275° F., plus peak temperatures in excess of 300° F. They found, in addition, that HYPALON combined all the other needed properties – such as resistance to ozone cracking, corona cutting, flexing and oil.

Just as it helped Ford engineers solve their problem, HYPALON's unique combination of properties have made it the preferred elastomer for a variety of automotive applications. Durable, weather-resistant coatings for window seals, colorful headliner coatings, heat and ozone resistant spark plug boots . . . these are just a few.

Alone or in combination, HYPALON and neoprene, another Du Pont synthetic rubber, continue to solve functional and style problems that arise in the automotive industry. Our elastomers publications contain many ideas on how you can put them to good use in your own projects. For future copies, mail the coupon today.

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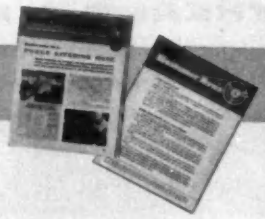

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THERE'S A NEW BABY COMING AT THOMPSON—rear suspension components that will help improve the ride of your models of the future. These are Thompson's latest developments and they come from the same Michigan Division research center that produced front wheel suspension ball joints, as well as many other chassis parts. We'll be happy to show you how you can use these new Thompson products to your advantage. Why not call Jefferson 9-5500, or write us at 34201 Van Dyke, Warren, Michigan.

You can count on **Thompson Products**

Michigan Division: Warren and Portland

gine with a power take-off shaft, and costs less to install than separate units. Responsibility would lie with one manufacturer, not two, and that would be a boon to users.

To Order Paper No. 58B . . . on which this article is based, see p. 5.

4 Goals for Ideal Refrigeration Engine

Based on paper by

M. S. SUTTON
Thermo King Corp.

GROWTH of mobile refrigeration depends upon the success of the automotive industry in supplying completely reliable, long-lived powerplants. Four essentials for the ideal engine are:

1. Light weight. There's need for wider use of the light metals.
2. Small size.
3. Larger oil capacity and minimum oil consumption.
4. One season, or 3000 miles, between overhauls.

Existing powerplants have to be decarbonized after approximately 500 hr of use and undergo a major overhaul at least every 1500 miles. Points and plugs require continuous maintenance, and replacement as often as every 250 hr. Oil pans are inadequate in size so that users have to instal special large-capacity ones for long hauls.

To Order Paper No. 58D . . . on which this article is based, see p. 5.

Develops Starter Kit For Refrigeration Unit

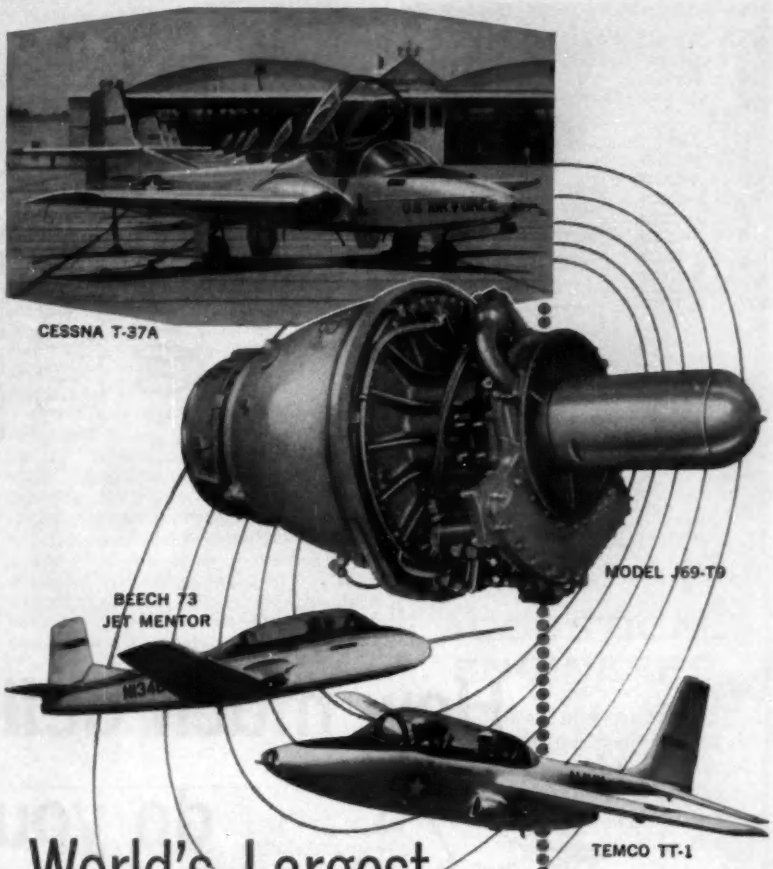
Based on paper by

F. B. ESTY
Wisconsin Motor Corp.

WISCONSIN Motor has developed a remote control kit which makes possible ground-level starting of refrigeration-unit engines mounted high on the front of a trailer.

The kit comprises a box containing ignition and starting switches, choke control, and a quick-disconnect for the electrical wiring. All parts are mounted permanently on the front or side of the trailer. Energy to run it is provided by the truck battery. Ignition is by magneto so that the unit operates independently of the tractor except for starting, which still can be done manually in an emergency.

To Order Paper No. 58A . . . on which this article is based, see p. 5.



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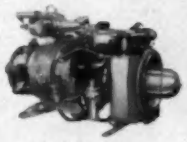
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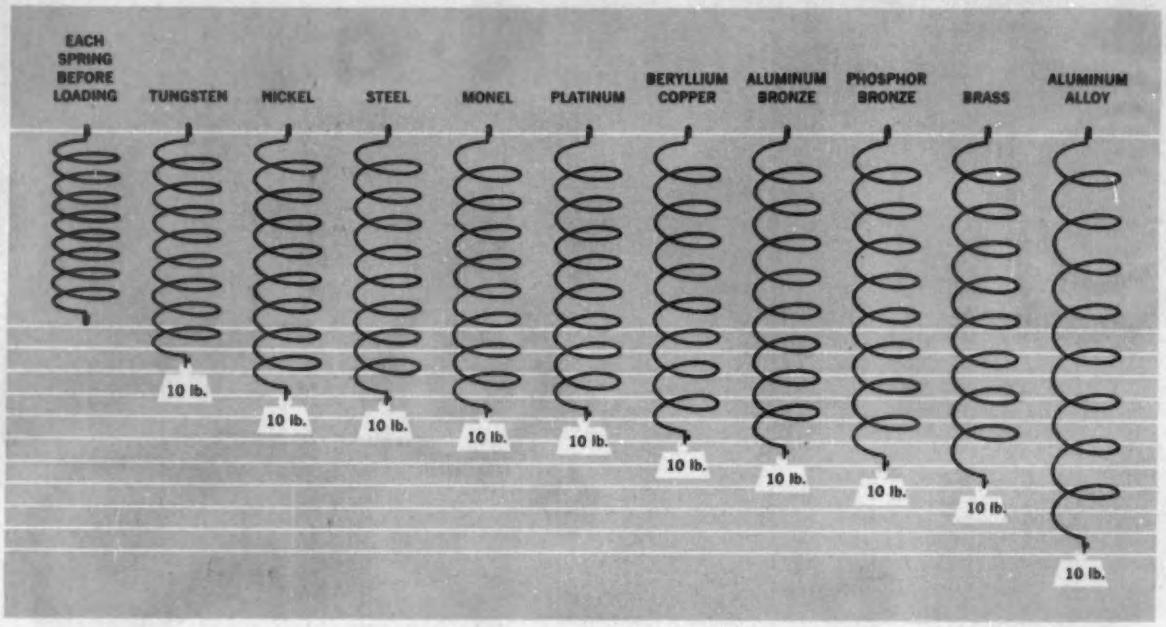

How much deflection do you want in a spring ?

The wide range of stiffness characteristics available in different materials offer unusual opportunity to solve spring deflection problems. How wide is shown in the chart above. The tension springs are all of identical dimensions but of different materials and indicate the relative deflection obtained from applying the same load (assuming the stresses are within safe limits). This basic principle is often overlooked in the approach to spring selection not only of extension springs but other types: flat, torsion, etc. Because our daily work includes such a wide range of spring usage, we are in a position to help you in the early stages of spring consideration, both in material selection and production short cuts. A handy pamphlet to have at your elbow is our "Metal Selector." Write for your copy.

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Db vs Sones—Or Is That Truck Too Noisy?

Based on paper by

DEAN G. THOMAS
Nelson Muffler Corp.

THE SONE system of measuring sound is not only newer than measuring decibels on a sound level meter — it's more realistic, too. The decibel setup consists in making simple, overall noise readings, but it doesn't take into account the frailties of the human ear the way the sone system does.

Decibels

To determine whether a truck complies with local sound regulations, law enforcement agencies still, however, use the decibel measurement of sound. The reason is that the decibel meter is a compact unit, very portable, and easily understood — for it gives a single reading directly in decibels.

Sones

The sone method gives a more accurate determination of sound as it affects the human ear, but it is too complex for law enforcement agencies to use.

The noise of a passing vehicle is picked up by a microphone 5 ft from the ground and 50 ft from the line of traffic. A recording is made and the sound is analyzed in eight octave bands from 37/75 cps through 4800/9600 cps. The readings are in decibels. By proper conversion tables these eight decibel readings are converted to sones, a unit of loudness that also give appropriate weight to the annoyance factor of different frequencies. When added together the total sone readings agree quite closely to noise ratings established by juries. The SAE and the AMA have adopted the Armour-Beranek/ATA system and have set a standard of 125 sones as the maximum allowable for approved vehicles.

One advantage of making a sound recording is that it can be played back in the laboratory and compared to other standards of muffling with such rapidity that the listener does not forget the comparison. In addition, the spectrum can be plotted in octave bands or in any other frequency band desired. The design engineer can thus concentrate his efforts on the frequencies that require the greatest amount of attenuation.

To Order Paper No. 56A . . . on which this article is based, see p. 6.

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Briefs of SAE PAPERS

Continued from page 6

formance; availability of improved detergents and laboratory tests provide means of designing lubricating oils to satisfy requirements.

GROUND VEHICLES

"Don't Overlook Leaf Springs", C. W. BARTLETT. Paper No. 51A. Presented June 1958, 4 p. Requirements and design considerations for three groups of vehicles: light commercial, including panel deliveries from ½–3-ton payload; medium class, including overhighway tractors of single axles and other vehicles up to 20,000 lb GVW; dual axle heavy duty trucks on and off highway service, including special dump trucks of capacities up to 50-ton payload; spring materials used; advantages of leaf spring.

New Developments in Torsion Bars, R. E. HANSLIP, L. O. IMBER. Paper No. 51B. Presented June 1958, 13 p. Possible variations of torsion bar springs which were considered in Mather Spring Co.'s research program; design of laminated torsion spring is divided into two categories: that of narrow plates where torque due to secondary stresses can be ignored, and that of wide leaves where secondary stresses contribute substantially to torque developed by spring.

Vehicle Suspension Using Coil Springs, M. C. TURKISH. Paper No. 51C. Presented June 1958, 15 p. Basic merits of helical coil springs featuring good characteristics at lower cost; comparison of energy storage in steel springs; five different types of ends formed from alloy steel bars; method of calculating normal coil spring load and rate required for independent front wheel suspension; applicability of systems to buses, armored cars, etc.; examples.

Hydraulic Controls for Trucks and Buses, T. H. THOMAS. Paper No. 52A. Presented June 1958, 9 p. Some of hydraulic components and accessories, other than transmissions, including power steering gears, systems for raising or tilting dump truck bodies, for actuating elevating mechanisms, and for operating bulldozer blades, etc.; hydraulic drive for truck and trailer refrigeration systems; control system on 433 Mack C-50 buses.

Electrical System for Trucks, H. L. HARTZELL. Paper No. 52B. Presented June 1958, 15 p. Merits of electrical system for starting motor, windshield wipers, circulating fans, horns, magnetic clutches, fuel pumps, cab tilting, etc.; ability of electric systems to replace hydraulic ones considered with respect to hoists and power steering; it is shown that electrical system can be extended to provide some of services supplied by hydraulic and pneumatic systems.

Modern Truck Transmissions, R. E. McAFEE. Paper No. S83. Presented Mar. 1958, (Texas Gulf Coast Sec.) 10 p. Operating characteristics of various transmissions as follows: fully automatic transmissions; automatic, semi-automatic, and standard transmission; vehicle performance and advantages of use of torque converter; fuel economy results from field tests undertaken by International Harvester Co. on Se-

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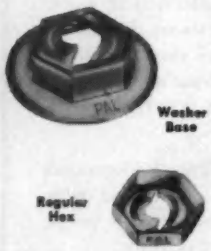

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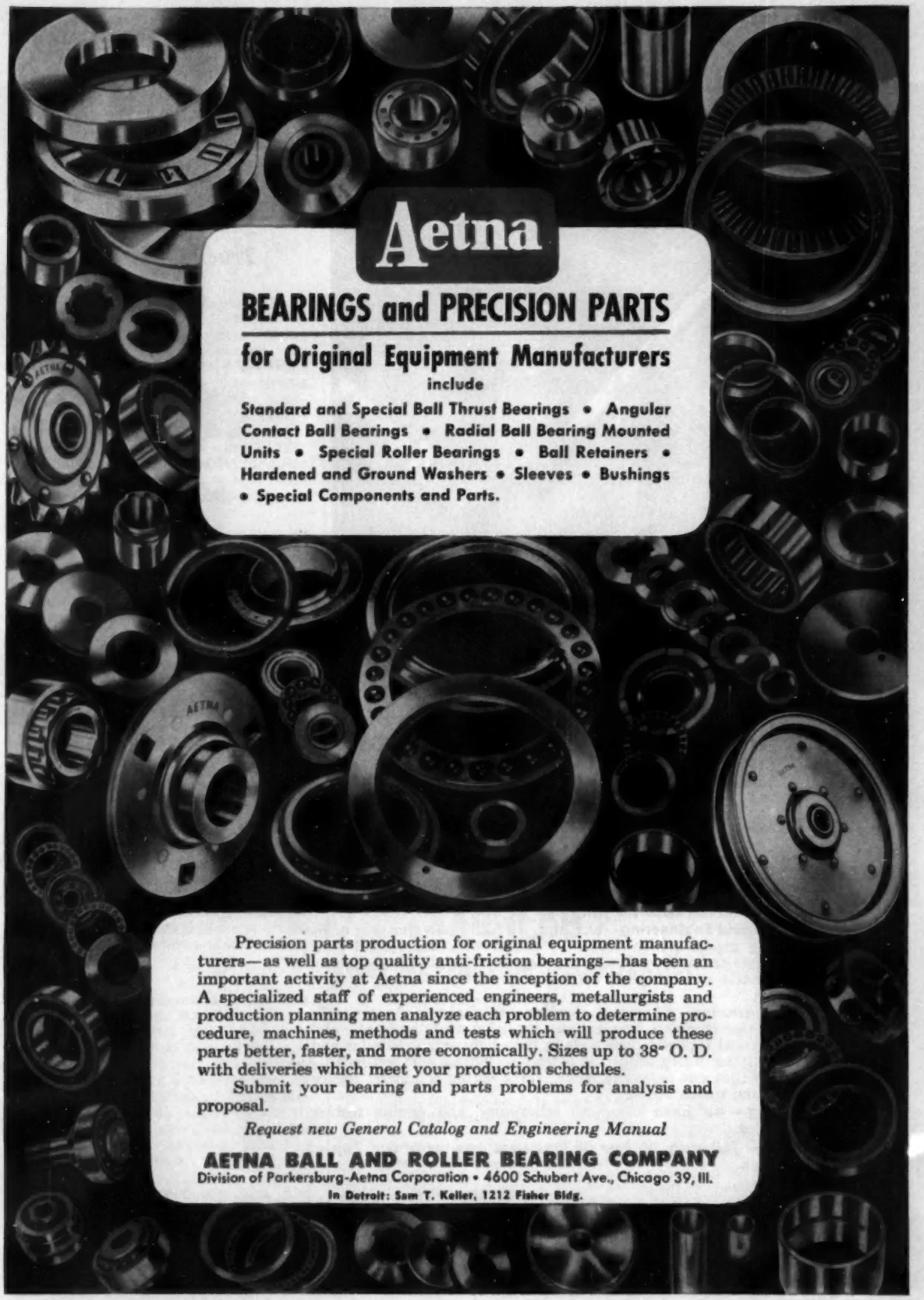
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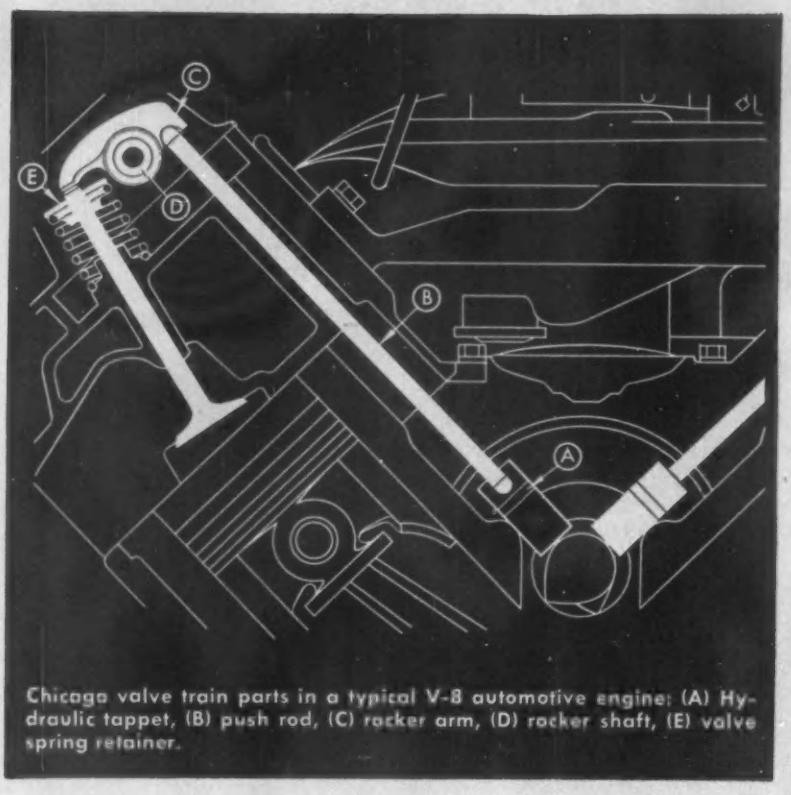

Chicago valve train parts in a typical V-8 automotive engine: (A) Hydraulic tappet, (B) push rod, (C) rocker arm, (D) rocker shaft, (E) valve spring retainer.

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lect-o-Matic transmission with highway ratios.

Fundamentals of Earthmoving, R. H. HUNGER. Paper No. 884. Presented Mar. 1958, (Buffalo Sec.) 5 p. Three basic tools are bulldozer, scraper, and motor grader; factors affecting proper selection depending on job conditions are rolling and grade resistance, traction, and altitude; recent improvements include Caterpillar No. 8 tractor mounted ripper having ability to tear up hard material, and Gyro-dozer which will pry out stumps and rocks and finish bulldoze smooth surface.

Engineering Diesel Poppet Valves, J. M. CHERRIE, M. J. TAUSCHEK. Paper No. 888. Presented Mar. 1958, (Cleveland Sec.) 10 p. Valves impose manufacturing problems because of variety of fuels burned, and applications ranging from light weight automotive to heavy duty stationary engines; effect of environmental conditions; exhaust valve operating at elevated temperatures as limiting factor in valve train durability; importance of knowledge of valve temperature; valve corrosion problems.

Pneumatic Power Control Systems for Trucks, Trailers and Buses, S. JOHNSON, Jr. Paper No. 52C. Presented June 1958, 15 p. Principles of basic air brake system for trucks, trailers and buses; additional functions or application such as air suspension; air powered steering; engine auxiliary controls: air assist booster type for clutch control; antiskid devices; transmission shifters; crane and shovel controls.

Why Chassis Dynamometers in Fleet Maintenance, G. R. MACKEY. Paper No. 55A. Presented June 1958, 18 p. Averages taken from fleet surveys and analyses show that fleet of 51 vehicles can expect to save $17.85 per day, by including planned Chassis Dynamometer Test Program as regular part of its maintenance operation; its use yields economies in four important phases of vehicle maintenance: final adjustments, diagnosis, checking repairs, and periodic inspections; data and comparison analysis.

Truck Exhaust System Noise — Problems and Solutions, D. G. THOMAS. Paper No. 56A. Presented June 1958, 20 p. Discussion confined to noise problems related to exhaust system of heavy duty trucks; its components such as manifold, exhaust tube, tail pipe, and fittings and brackets; factors to consider in muffler design and construction; methods used in measurement of noise; theoretical acoustics as applied to mufflers; future developments. 22 refs.

Truck Tire Noise — Problems and Solutions, I. A. ROBERTSON, J. H. COX. Paper No. 56B. Presented June 1958, 7 p. Factors in tire tread design which affect its noise characteristics; equipment used for investigating noise on smooth drum at Firestone Farm Tire Test Station at Columbiana, Ohio; study of noise levels to establish fundamental principles of relation of tread design to noise; role of tire noise

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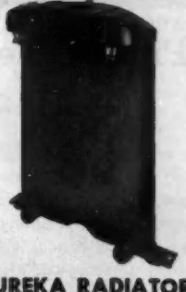

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Briefs of SAE PAPERS

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to overall truck noise problem; examples of design configurations.

Methods to Reduce Cooling Fan Noise, K. A. BEIER, T. J. WEIR. Paper No. 56C. Presented June 1958, 9 p. Design, shapes and forms that can be applied, such as on- and off-type, variable pitch blade, and infinitely variable speed designs; latter offers best approach; analysis of cooling fan requirements with varying temperature differentials between top tank and entering air temperatures; air flow requirements from fan at various differentials along with fan speed, power and noise levels.

1958 Thunderbird — Design and Development, D. N. FREY, J. R. HOLLOWELL, J. L. MARTIN. Paper No. 59A. Presented June 1958, 21 p. Engineering program and design objectives for transforming Ford 2-seater sports car to 4-passenger car; considerations regarding entrance dimensions; unit body-frame construction and tests involved; 90° overhead valve V-8 engine of 352 cu in. develops 395 lb ft of torque at 2800 rpm and 300 hp at 4600 rpm.

Unitized Approach to Low Cars, H. W. JOHNSON. Paper No. 892. Presented May 1958, (Detroit Sec.) 8 p. Tunnel, engine, and exhaust problems; approach taken for Lincoln 1958 called for unitized form of construction; five main subassemblies are underbody with longitudinal and transverse reinforcements, left and right body sides, cowl assembly, and roof panel; basic strength is in underbody, in which rocker panels are reinforced to serve as beams resembling frame side rails.

Bodies, Frames, and Low Profiles, P. O. JOHNSON. Paper No. 893. Presented May 1958, (Detroit Sec.) 14 p. Critical item directly affecting height of current American 6-seat passenger cars is not influenced by choice of integral or separate chassis frame; reduction of three dimensions which largely control height of car considered; possible seating attitudes, possible future chassis frames and solutions, discussed.

Foreign Car Body Design, G. A. SMITH. Paper No. 891. Presented Mar. 1958, (Detroit Sec.) 13 p. Paper divided in three parts: styling, includ-

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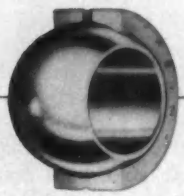

This cutaway view of the Unibal 2-piece spherical bearing shows how a coined (or swaged) type bearing presents a large surface-supporting area, and is capable of rotating so as to correct shaft misalignment in all directions.

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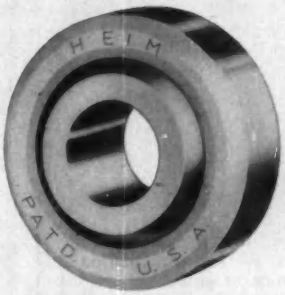
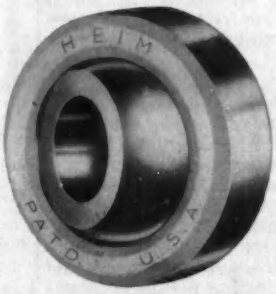


These new Unibal spherical bearings of sintered metal cost less than comparable bearings of conventional materials.



Like all Unibal spherical bearings and rod ends, the new 2-piece bearing produced by powder metallurgy, will correct misalignment to the maximum degree.

Briefs of SAE PAPERS

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ing variety of models available and volume of production; size, including weights and dimensional comparisons; structure, including details of Opel, Vauxhall and Holden assemblies; midget cars; tabulation of models available; how legislature influenced some design features.

MISCELLANEOUS

Gas Turbines in Marine Naval Service, J. S. PASMAN. Paper No. 887. Presented Feb. 1958, (Baltimore Sec.) 10 p. Gas Turbine Engine Section of US Naval Engineering Experiment Station, Annapolis, Md., is engaged in testing and development of engines; details of three small open cycle turbines, fire pump driven by 45-hp constant speed Solar gas turbine, small boat propulsion package driven by 160-hp variable speed Boeing turbine for landing craft and mine sweepers, and 250-kw emergency generator set, driven by 400-hp Solar gas turbine; advantages.

New Industrial Tools Utilizing Phosphors, C. W. WALLHAUSEN. Paper No. 53C. Presented June 1958, 6 p. Two specific developments for immediate industrial application considered: isotope activated self-luminous light sources and thermographic phosphors; steps involved in method of using phosphor; possibility of combining certain features of isotope activated light sources and thermographic phosphors.

Presented here are brief digests of recently presented SAE papers. These papers are available in full in multilith form for one year after presentation. To order, circle the number in the "Reader Information Service" blank on page 6 corresponding to the numbers appearing after the titles of the digests of interest to you.

These digests are provided by Engineering Index, which abstracts and classifies material from SAE and 1200 other technical magazines, society transactions, government bulletins, research reports, and the like, throughout the world.

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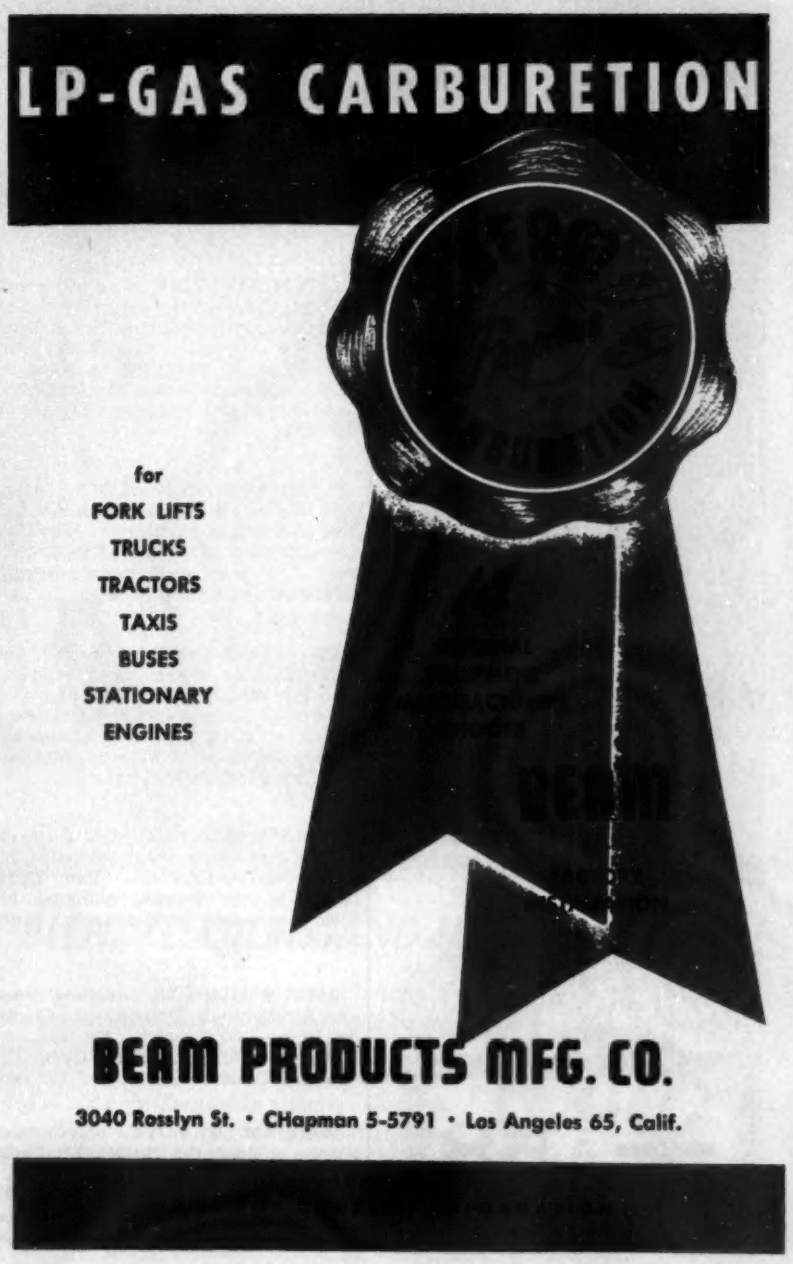
. . . 1958 SAE NATIONAL PRODUCTION FORUM, presented March 31–April 1. Secretaries' report of 8 panels on "Automation in Assembly," "Quality Control — How Much Can You Afford?," "Coordination Between Engineering and Manufacturing," "What's New in Foundry Techniques?," "Quality and Quantity in Production Heat Treating," "What Can a Computer Do for Production?," "Manufacturing Cost Control," and "Numerican Control." Available as SP-322 from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: $1.50 to members; $3.00 to nonmembers.

. . . 1958 SAE NATIONAL AERONAUTIC PRODUCTION FORUM, presented April 8–9. Secretaries' report of 6 panels on "Getting Optimum Results in Manufacturing," "Procurement," "Improving Productivity Through Releasing Greater Human Potential," "Company-Wide Approach to Improvements in Productivity," "Scientific Quality Control — New Production Tool," and "New Product Adaptability." Available as SP-323 from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: $1.50 to members; $3.00 to nonmembers.



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About SAE Members

Continued from page 97

WILLIAM T. TIERNEY has become assistant superintendent of the Texaco Research Center at Beacon, N. Y. Previously, he was assistant supervisor of the products application department at the center.

L. C. WOLCOTT, who has been chief engineer for the Packard Electric Division of General Motor Corp., has become director of sales and engineering for the division.

MARVIN WHITLOCK, vice-president of Operations Planning for American Airlines, Inc., spoke at the Seventeenth Annual National Conference of the Society of Aeronautical Weight Engineers, held in New York May 19 through 22.

A. B. HIRTREITER has been named a chief engineer in the development organization of Goodyear Tire & Rubber Co.'s Industrial Products Division. He will direct development work on automotive suspensions. Hirtreiter has been senior development engineer in charge of air suspension.

C. EDWARD YOUNGMAN is now engineering control coordinator for the Missile Systems Division of Lockheed Aircraft Corp., Palo Alto, Calif. Formerly, he was staff assistant with Temco Aircraft Corp., Dallas.

CHARLES E. LaBELLE has accepted a position as development engineer with the Wright Power Saw and Tool Division of Thomas Industries, Sheboygan, Wis. He was previously application engineer with Clinton Machine Co., Inc., Maquoketa, Iowa.

DONALD C. DICKINSON, formerly West Coast service representative for Holley Carburetor Co., Van Dyke, Mich., is now general manager for Tube Specialists of California, Santa Ana, Calif.

JACK B. SPARKES is regional manager for Plymouth Division with Chrysler Corp., Los Angeles. He was formerly regional manager for Dodge Division in Dallas.

WILLIAM B. LOVE, chief truck chassis engineer for Studebaker-Packard Corp., has been elected vice-chairman of the special road test committee of the Automobile Manufacturers Association.

STRONGEST MAN IN WHEELS

Call on the most complete design-to-delivery-date service in the wheel industry today.

Your ELECTRIC sales engineer holds up his end and then some! Call on him to put his shoulder to your problem with quick answers and cost-cutting suggestions for new designs or redesigns.

Call, too, on the famous follow-through that only ELECTRIC's automated operation, handy location and wide agricultural and industrial experience offer you.

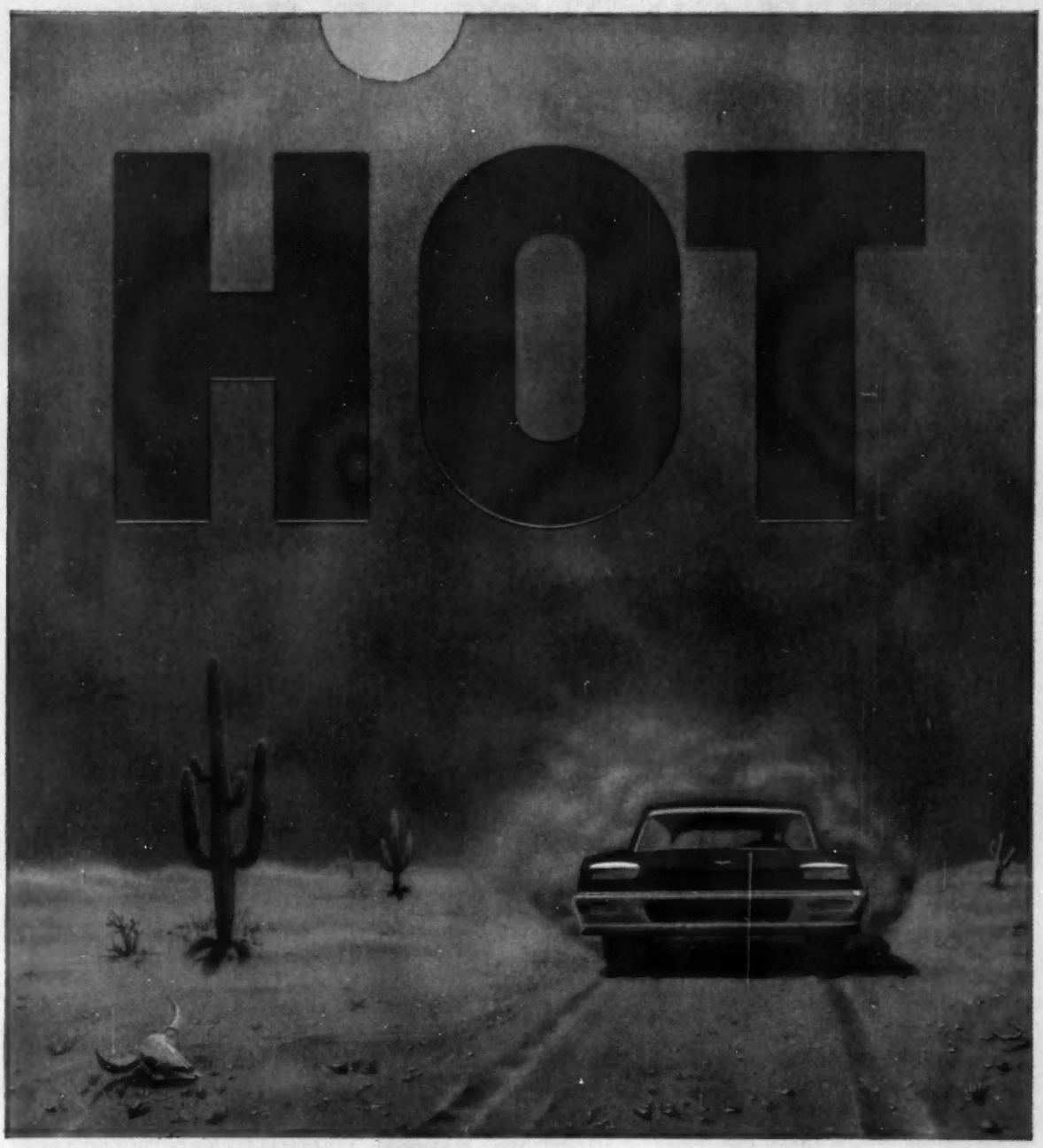
For the precise disc or spoke-type wheel (steel or rubber-tired), rim, hub, axle or component part you want, call or write today.

"What we sell is service"

ELECTRIC WHEEL CO.

Write to Department 11B,
1120 N. 28th St., Quincy, Illinois, BAldwin 2-5320

DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY



OR COLD... PARATONE-BLENDED OILS STAND UP!

When the heat's on, inside and out . . . metal-scorching temperature in the engine—sweltering radiation from the hot summer sun . . . ordinary oils become dangerously thin. But oils blended with Enjay Paratone® viscosity index improver stand up to oil-thinning heat and retain their lubricating viscosity. Yet when winter sets in, Paratone-blended oils do not congeal to a heavy, sluggish oil. They provide instant lubrication to all parts for quick, cold weather starting. Enjay has developed the only complete line of high quality additives (Paramins®). To meet the most exacting oil specifications, insist on Enjay Paramins.

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letters from readers...

From:
Marcellus Merrill
Merrill Engineering Laboratories
Denver, Colo.

Dear Editor:

I would like to comment on the article, "How an SAE Paper Is Born" in your June, 1958, issue.

This article illustrates very well the reason that practically all SAE Journal articles and SAE papers are written by company men. As the article said, it costs around $5000 for the company to put out the paper. A man also had to be given time to get the information together. This is something that the small business man does not have—either the money or the time. The same can be said of many inventors who still exist outside company laboratories in this country.

I know this is just the trend of the times. If I were an official of SAE I would say it is impossible for SAE to finance papers from individuals, no matter how brilliant they are in their field. Cost prohibits you in your choice.

Yet, as a recent Harvard Business Review article states, most of the outstanding brains in the business world are concentrated in small businesses. And, even though radio, television, and advertisements constantly remind us of the great achievements of the large company laboratories, the truth of it is most inventions of the last 100 years have come from the lone-wolf inventors.

These facts were certainly well expounded in an article in Lloyd's Bank Review by John Jewkes. "Even the rockets on which we are now spending billions," he states, "were first promoted in the 20's and 30's by a group of young German amateurs." It was not until World War II that the German military took the project and finally produced the V-2. Over 50% of U.S. patents are issued to individuals. Certainly in the last 30 years some of the outstanding automotive and electrical inventions have come from individuals.

The result is that our great engineering magazines, such as the SAE Journal and others, are more or less large company publications. Many of the articles are more or less minor modifications, improvements in techniques. This, too, is the trend of modern times which neither you nor any other editor can prevent. The truth is that we are not getting to the basic original thinking of the great mass of thinkers in our country.

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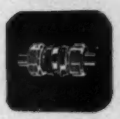
PATENTED CLUTCH LEVERS •

Small Spring Loaded

Heavy Duty Spring Loaded


Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Speed Reducers

• Reduce friction and wear • Improve clutch release action • and Prevent lever throw-out

You get these patented features—in addition to (1) as many as twenty four heat-resistant, non-set springs to assure even pressure all around the plate and long service life (2) nine large side ports and twenty one holes in the cover to carry away heat, dirt, grease and moisture (3) balanced, function-simplified levers to insure efficient operation in high-speed, high-torque engines (4) cushioning and dampening arrangements to minimize shock-load effect and blot out vibration (5) a wide variety of organic, metalic, or Morlife® friction plates. When you specify ROCKFORD you get ALL of these advantages that enable ROCKFORD CLUTCHES to serve better and longer than any "chinese copies".

BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER
316 Catherine St., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

From:
R. D. Wallace
Director of Engineering
Diamond T Motor Truck Division
The White Motor Co.

Dear Editor:

The upper left-hand picture on page 62 of your May 1958 issue (in the article titled 'Truck Cabs Need Further Improvements') was taken of a purely experimental job of ours which was loaned to one of the insurance companies for some brake testing.

It is the only unit (the only one we have ever built) that had a clutch pedal of this type and on which the seat had to be thrown completely out of adjustment to get this condition.

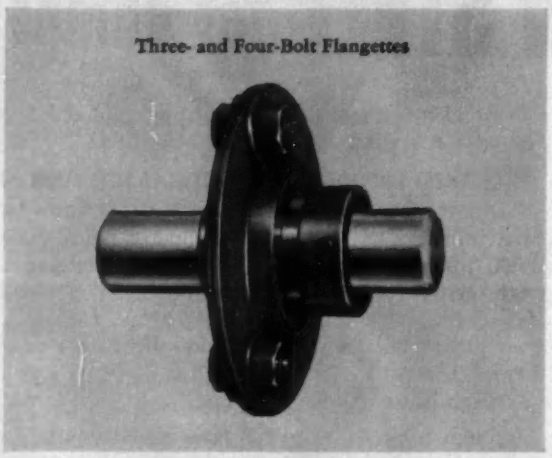
Of course, maybe some of the others

Continued

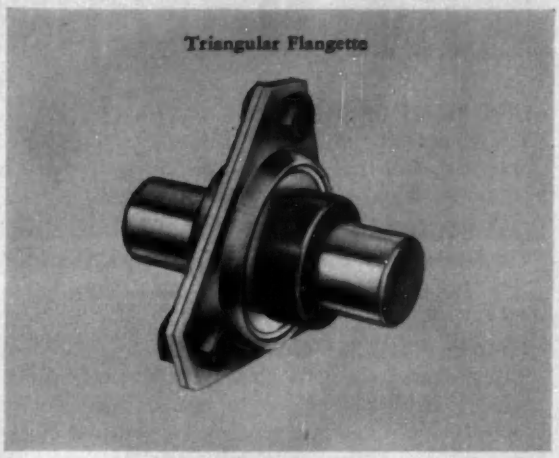
SHAPED TO FIT YOUR NEEDS!

Cost-wise... Design-wise

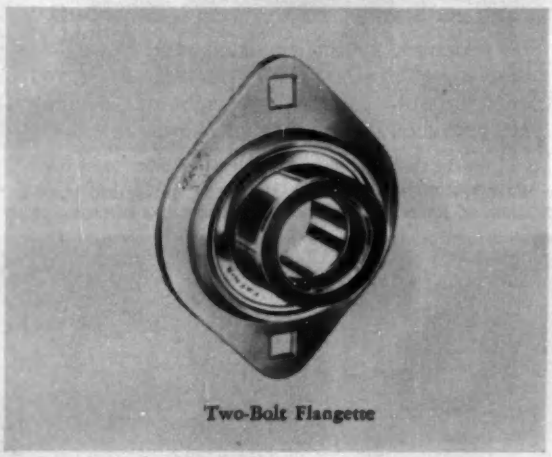
Three- and Four-Bolt Flangettes



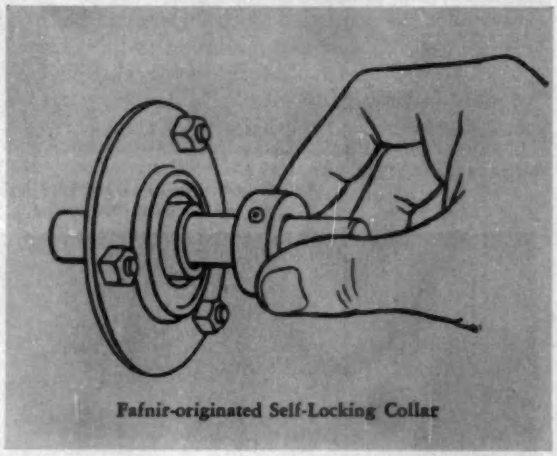
Triangular Flangette



FAFNIR FLANGETTE FAMILY



Two-Bolt Flangette



Fafnir-originated Self-Locking Collar

The original Flangette, introduced over a decade ago by Fafnir, offered for the first time the cost-cutting advantages of a "packaged", ready-to-mount ball bearing unit—complete with self-contained housing, prelubricated bearing, and integral seals.

Today's "Family of Fafnir Flangettes" meets various *design* needs as well. In addition to the widely popular three- and four-bolt Flangettes, two-bolt and triangular types are now available. They were developed expressly for installation where mounting space is limited.

Slinger-type Mechani-Seals or, for slower speeds, contact-type Plya-Seals protect against contaminants and loss of lubricant. Wide inner ring or extended inner ring ball bearings may be specified. Both type bearings feature the Fafnir-originated self-locking collar that secures bearing to shaft with a twist of the wrist.

For full details on these low-cost answers to antifriction design problems, write The Fafnir Bearing Company, New Britain, Connecticut.

Extended Inner Ring Ball Bearing with Plya-Seals — RA Series
Wide Inner Ring Ball Bearing with Mechani-Seals — LL Series
Wide Inner Ring Ball Bearing with Plya-Seals — RR Series

FAFNIR
BALL BEARINGS

Why automotive manufacturers prefer N-A-X® FINEGRAIN STEEL for bumpers

WIDE RANGE OF SHAPES AND CONTOURS
The complexity of today's automotive bumpers demands a steel that provides maximum strength plus unlimited shape and contour possibilities.

FLAT POLISHES TO A HIGH LUSTER
The hardness and fine grain of N-A-X FINEGRAIN renders this steel capable of assuming a high degree of luster at minimum cost.

REDUCES POLISHING COSTS
Bumpers made of polished N-A-X FINEGRAIN suffer no surface disturbances due to coarse grain or strain caused by the drawing process. Preparation costs before plating are thereby reduced.

LESS OVERHANG WEIGHT
Generally, the most difficult bumpers can be made of N-A-X FINEGRAIN with a minimum of 25% increased yield strength over mild carbon steel. This makes possible greater resistance to indentation and substantially decreased overhang weight.

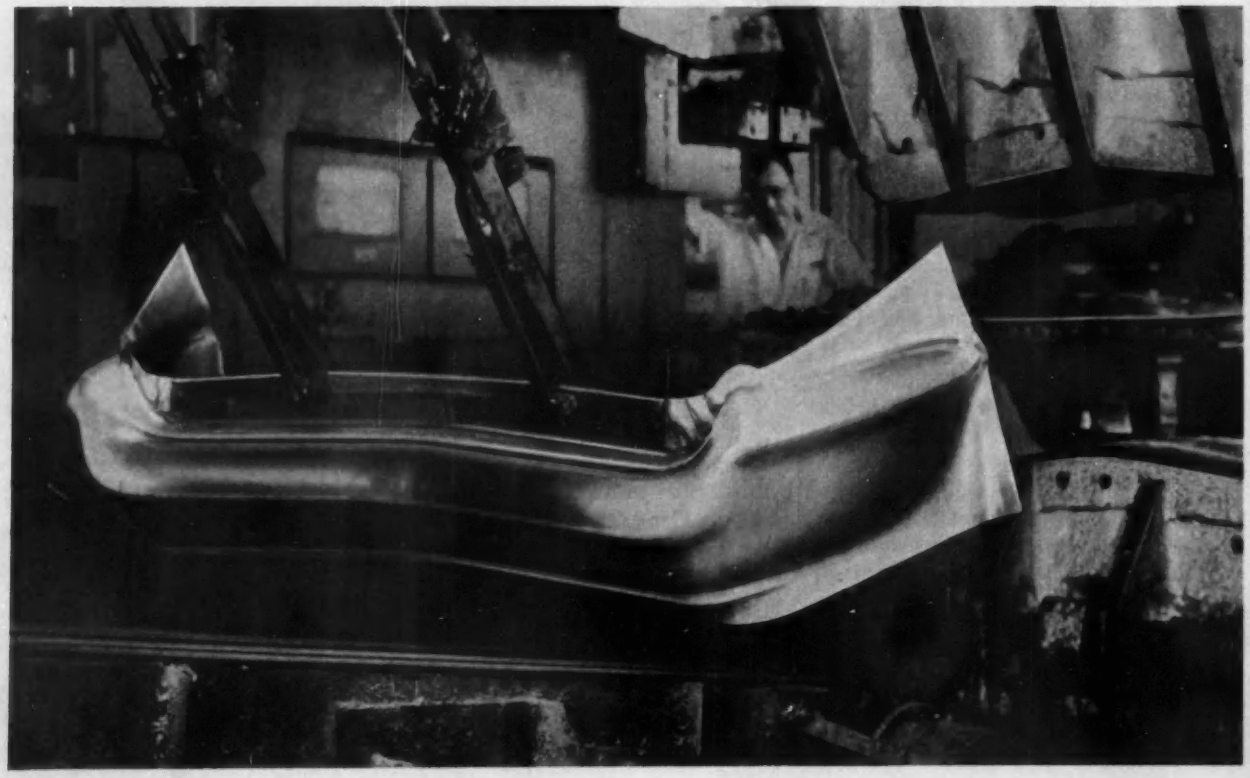
No wonder automotive manufacturers prefer dependable N-A-X FINEGRAIN for the difficult jobs.

CHECK THESE IMPORTANT ADVANTAGES FOR YOUR JOB:
N-A-X HIGH-STRENGTH steels—both N-A-X HIGH-TENSILE and N-A-X FINEGRAIN—compared with carbon steel, up to 50% stronger • have high fatigue life with great toughness • are cold formed readily into difficult stampings • are stable against aging • have greater resistance to abrasion • are readily welded by any process • offer greater paint adhesion • polish to a high luster at minimum cost.

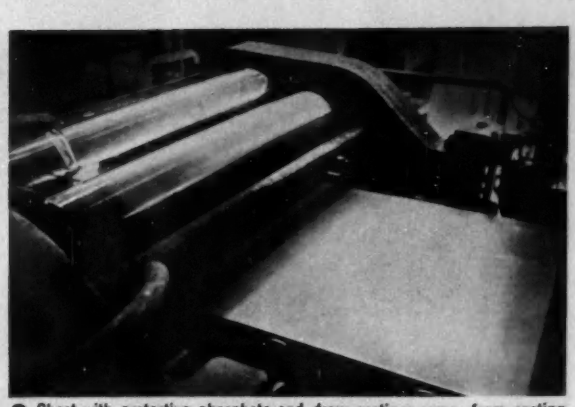
Although N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon steel, N-A-X HIGH-TENSILE is recommended where resistance to extreme atmospheric corrosion is important.

For whatever you make, from steel boats to steel bumpers, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight and economy into your products. Let us show you how.

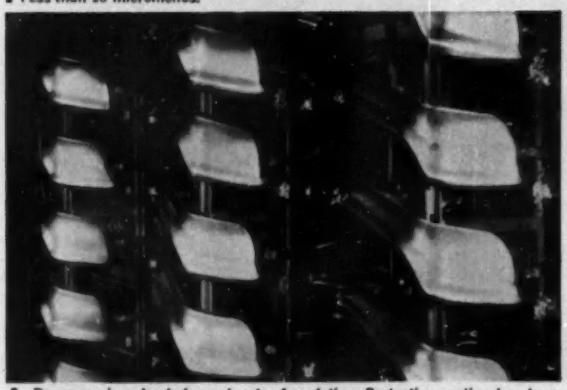
3 Bumper wings, drawn double from N-A-X FINEGRAIN, emerge from press. After splitting and trimming, the protective draw coating is removed. Contoured bumper is then ready for plating without subsequent polishing.



1 Hot rolled N-A-X FINEGRAIN sheets come out of flat polish with a finish of less than 10 microinches.

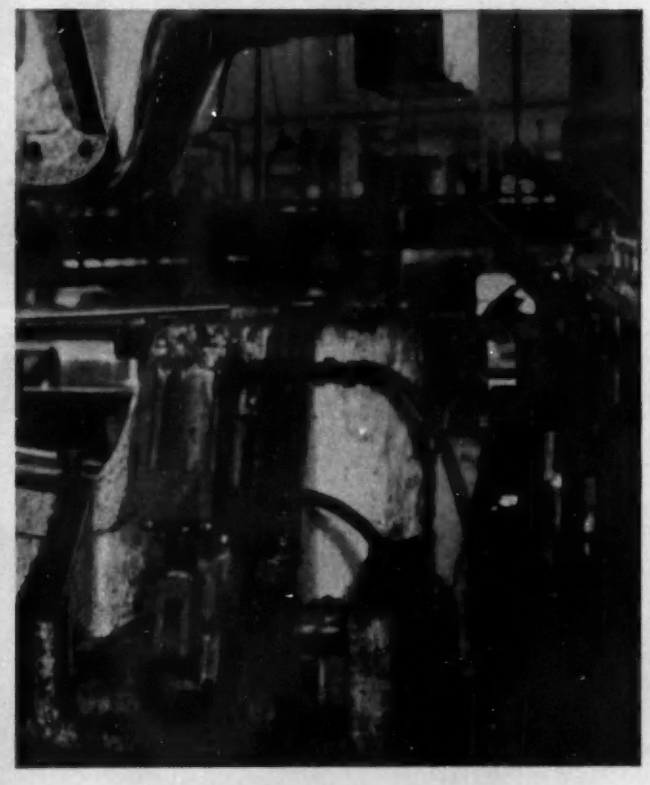


2 Sheet with protective phosphate and draw coatings comes from coating machine ready for the draw press.



4 Bumper wings loaded on elevator for plating. Protective coating has been removed. Note no surface disturbances occurred after drawing operation.

5 Final inspection after plating. No expensive hand-polishing was required from original flat polish to plating operation.



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- **STRONG**
- **FLEXIBLE**
- **DURABLE**
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This light, strong, flexible tubing meets stringent performance requirements at a fraction of the cost of metal tubing with required flexible couplings and intermediate fittings. And it is easier to install—saves assembly time. Available in 1000 psi and 2500 psi grades which conform to J.I.C. specifications for low and medium pressures.

Advantages include: high pressure rating at low cost; long flex and vibrational life; resistance to oils, greases, solvents; wide service temperature range; crush and abrasion resistance adaptability to standard metallic fittings.

Other feasible automotive applications are lubrication systems, fuel lines, oil lines, hydraulic systems.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses in the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket
Plastics Division of GARLOCK

letters from readers...

Continued

of the pictures that are taken here, are cabs as identifiable to their producers as this one is to us, but nevertheless this does leave a little regret in our minds.

•———•

From:
G. E. Adams, Chassis Engineer
Lincoln Product Engineering
M-E-L Division
Ford Motor Co.

Dear Editor:

In the May issue of the Journal on page 25 in your "Chips" column, it is reported that "Ball joint suspensions were introduced in 1954 by three manufacturers . . ."

I believe this is a case of accurate reporting of poor information—but would like to submit that ball joint front suspensions were introduced by Lincoln on its 1952 models.

•———•

From:
Oliver Perkins
Director of Faculty
Northeast Schools
New Haven, Conn.

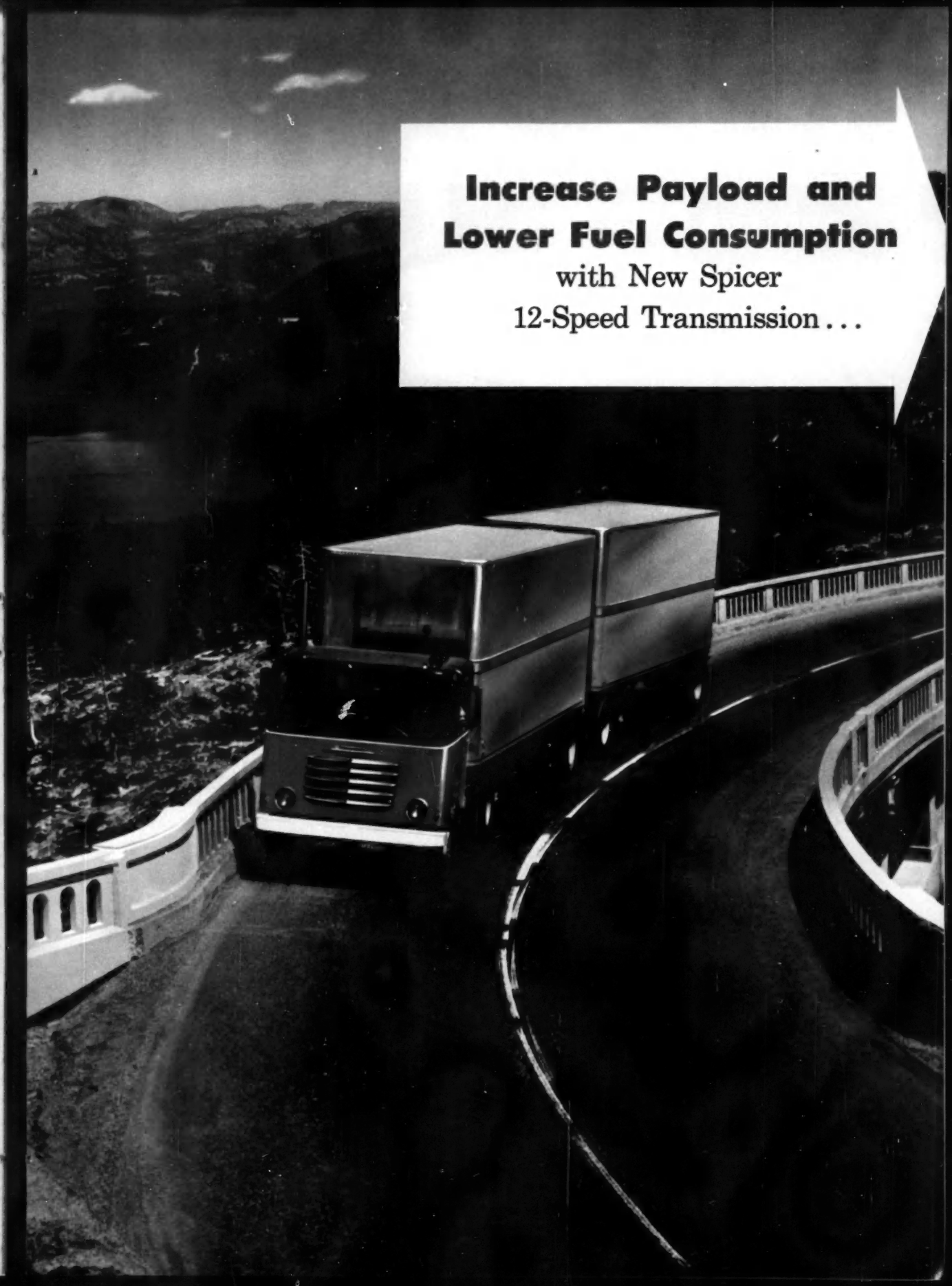
Dear Editor:

Northeast Schools are instituting a training course on jet-gas turbine engines. The course will be at the technician or sub-professional level for high school and technical school graduates—or for older individuals with appropriate experience and education.

We would welcome advice from SAE members as to the following:

- The potential future demand by industry for jet-gas turbine engine technicians in the production, maintenance, inspection, overhaul, testing, flight operations, and related fields.
- Types of job opportunities and rates of pay for personnel trained as outlined above.
- Broad subject matter which should be included in the curriculum to the best interests of both the student and potential employer to further the trainee's career.
- Recommendation for text and reference books, as well as charts, displays, mockups, and other training aids on the subject.

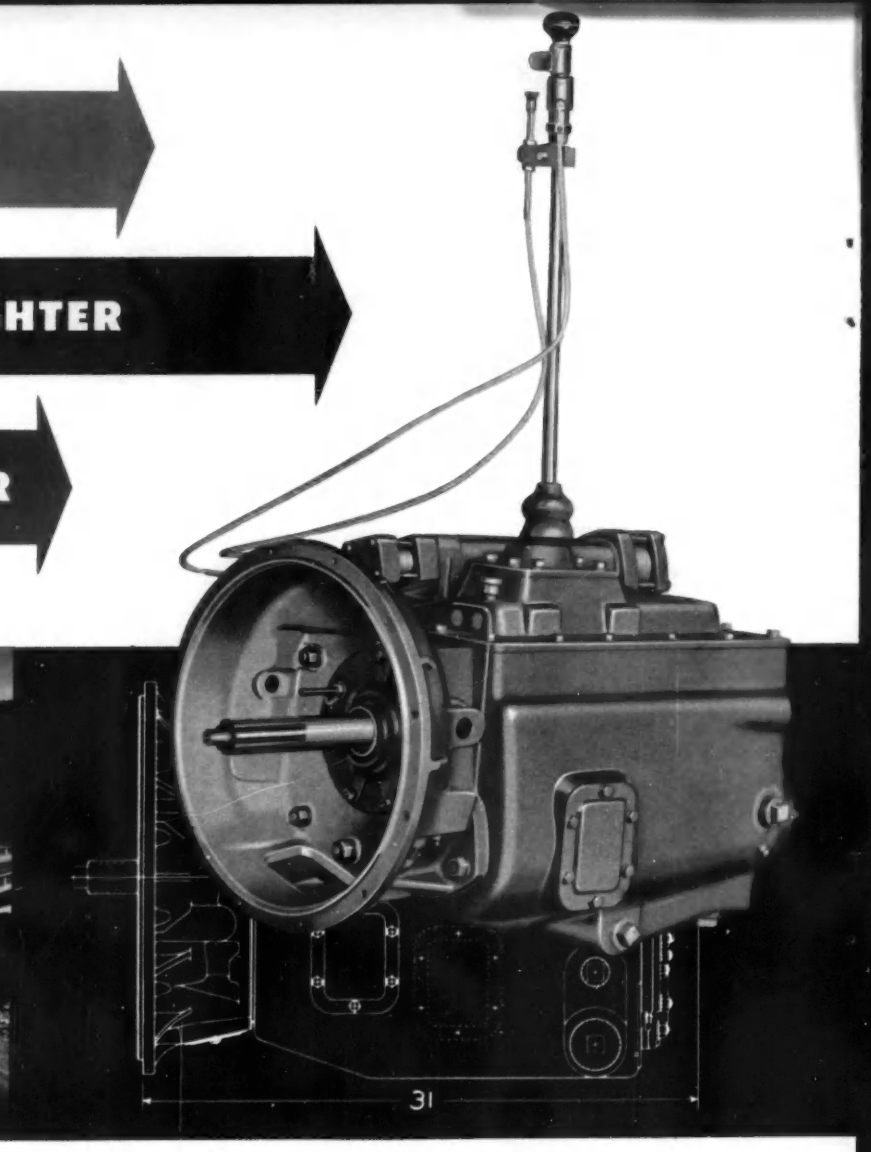
Our thanks to any who may be helpful.


Increase Payload and
Lower Fuel Consumption
with New Spicer
12-Speed Transmission . . .

12-SPEEDS

200 LBS. LIGHTER

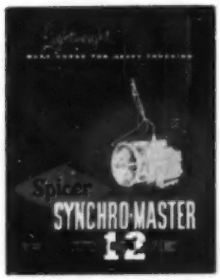
2 INCHES SHORTER



Now you can shorten the wheelbase by at least a foot, and increase payload by 200 lbs. At the same time you eliminate the auxiliary transmission and the two-speed axle.

No other transmission has ever given you so much efficiency—both on and off the highway—as your new Spicer Synchro-Master 12.

Write for booklet—Dana engineers want to help you adapt this revolutionary new Spicer transmission to your heavy-duty truck needs. Your letter, wire or telephone call will receive immediate attention.



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DANA PRODUCTS Serve Many Fields:

AUTOMOTIVE: Transmissions, Universal Joints, Propeller Shafts, Axles, Powr-Lok Differentials, Torque Converters, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Clutches, Frames, Forgings, Stampings.

INDUSTRIAL VEHICLES AND EQUIPMENT: Transmissions, Universal Joints, Propeller Shafts, Axles, Gear Boxes, Clutches, Forgings, Stampings.

AVIATION: Universal Joints, Propeller Shafts, Axles, Gears, Forgings, Stampings.

RAILROAD: Transmissions, Universal Joints, Propeller Shafts, Generator Drives, Rail Car Drives, Pressed Steel Parts, Traction Motor Drives, Forgings, Stampings.

AGRICULTURE: Universal Joints, Propeller Shafts, Axles, Power Take-Offs, Power Take-Off Joints, Clutches, Forgings, Stampings.

MARINE: Universal Joints, Propeller Shafts, Gear Boxes, Forgings, Stampings.

Many of these products manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

DANA
Spicer

New Members Qualified

These applicants qualified for admission to the Society between June 10, 1958 and July 10, 1958. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Baltimore Section

John Donnell Fraser (M), Roland C. Kleinfeld (J).

Buffalo Section

John K. Hulbert (M), Donald Earl Mastin (J), George S. Nash (M).

Canadian Section

Michael Bell (A), G. Richard di Dio (M), Desmond McIntosh Donaldson (M), William Edward Ecclestone (A), Reginald Arthur Hill (M), Donald S. Horne (M), Gordon Mason (M), Jack Skead McAvoy (M), William G. Preece (A), Gordon K. Trenholm (M).

Central Illinois Section

Keith Eugene Demorest (M), Frederic P. Emery (M), James E. Gee (M), Winton A. Hancock (J), Walter I. Haupt (M), Richard A. Madsen (J).

Chicago Section

Stanley C. Adamek (M), Raymond I. Birkholz (M), G. Robert Jordan (A), Gustave A. Limbach (M), Walter Murelis (M), James J. Nawrot (J), Kendrick O. Renz (A), Stanley James Roush (M), John H. Swats (M).

Cincinnati Section

George T. Monaghan (M).

Cleveland Section

Donald A. Clendenen (M), Carl S. Hellman (M), Roderick N. MacLeod (M), Robert M. Raney (M), Jan Uytterlinde (A), Stanley W. Worthington (J).

Colorado Group

Milford J. Bishop (A), David R. Kerr, Jr. (A).

Dayton Section

James E. Whelan (J).

Detroit Section

Dan H. Andrews (A), Burton Kelsey Arbuckle (A), Charles Ethan Beck (M), Henry C. Bujak (M), Joseph M. Callahan (A), Wayne K. Carson (M), James Cumming (M), Paul William Dullabaun (M), Ashley J. Freehan (A), Frank J. Kalvelage, Jr. (M), Ned P. Kimberly (M), John C. King (M), Charles Wm. Livingstone (J), Ralph K. Londal (J), James L. Martin (M), George J. Nebel (M), Paul Roscoe Norton, Jr. (J), John A. Olsen (M), Edward B. Porter (M), Giacomo Mario

Continued

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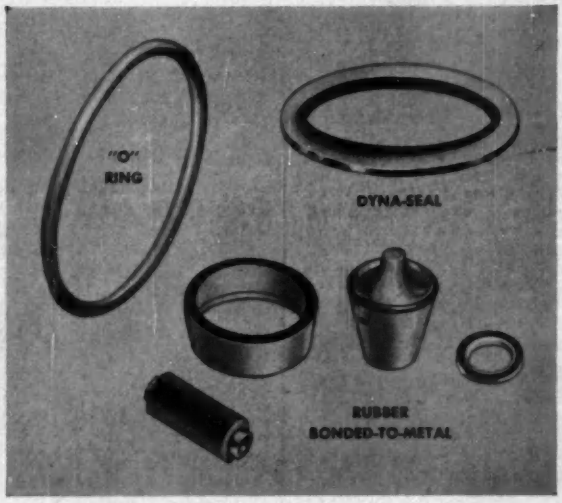
engineered specifically for your product

SIMPLE
RELIABLE
LOW COST
SPACE SAVING



"O" RINGS—Over 100 Inspections and Tests to assure dependable, accurate "O" Rings to meet all specifications. Prompt shipments from stock.

DYNA-SEALS—For face-to-face sealing. This rubber bonded-to-metal seal eliminates special machining, cuts assembly costs and is reusable. Sizes for No. 5 screw to 1¼" bolt.

RUBBER BONDED-TO-METAL—Engineered parts for specialized sealing services. Exclusive processes assure accuracy, dependability and long life.

Have a sealing problem? You'll find the answer at Precision. There's a Precision Engineer ready to help you.

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Precision Rubber Products Corporation · "O" Ring and Dyna-seal Specialists

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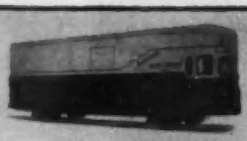


"THIS LUBRICANT SAVES US MONEY BY REDUCING LAY-UPS, PARTS REPLACEMENTS AND LABOR"

says INTERSTATE DRESS CARRIERS INC.
of New York and Leighton, Pa.

"If we were to state the percentage of savings we have made since using a LUBRIPLATE Lubricant for general chassis lubrication, it might appear that we were exaggerating. But our records speak for themselves. The four years we have used LUBRIPLATE have shown an astonishing drop in steering, universal joint and spring pin parts replacements. We plan to continue to use LUBRIPLATE exclusively."

Sidney Rothman, General Manager

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

LUBRIPLATE is available in grease and fluid densities for every purpose . . . LUBRIPLATE H. D. S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

New Members Qualified

Continued

Romeo (A), William Walter Ryba (A), Carl N. Schrader (M), Donald M. Spath (A), Alan R. Symonds (A), Waclaw Tarnowski (A), Richard H. Topp (J), Wayne A. Weaver (J), Walter H. Zimmerman (M).

Hawaii Section

Peter I. Sakamoto (A), Edwin Sorenson (M).

Indiana Section

Bernard H. Knell (M), Dwain A. Sylvester (J), Kent August Ziegler (M).

Metropolitan Section

John Athanasiou Anagnostos (A), George E. Brayman (M), Edward B. Capliski (A), Alfred Hovey Davidoff, Jr. (J), Carl Loftin Dellinger (M), Edward C. Joles (M), Clarence T. Kendall (M), Hideo Matsunaga (M), Edgar Wendell Nielsen (M), William J. Ormerod, Jr. (A), Alan Pinkus (M), Barret Towles Schleicher (J), Rocco P. Vallone (A), Theodore B. Wasserbach (M).

Mid-Michigan Section

Jack E. Kennedy (M), Carl G. Rummel (J), Leo W. Tobin, Jr. (M).

Milwaukee Section

Robert H. Bergquist (J), Robert L. Lewis (A), Elmer A. Rasmussen (M).

New England Section

Roy W. Barhydt (M), Arthur Napolitano (A), Ernest A. Sidney (A).

Northern California Section

William Alfred James Bryan (A), Paul Darneley Hobson (M), Bruce Colin Lindeman, Sr. (J), Peter R. McKenzie (J), Finn S. Reinath (M).

Northwest Section

James E. Murphy (A), John Arthur Ruggles (J).

Oregon Section

Wesley M. Foughty (A).

Philadelphia Section

Donald G. Albasi (A), Miles A. Bowman (J), Everett G. Harvey (M), David C. Hathaway (J), Tom Carlton Law (J), Ralph W. E. Leiter (M), Richard E. Newman, Jr. (A), Conrad R. Odden (J), James Edward Transue, Jr. (A).

Pittsburgh Section

Victor G. Erhart, Jr. (M), J. Rus-

Continued

work in the fields of the future at NAA

ELECTRO-MECHANICAL ELECTRONIC ENGINEERS

A BS or advanced degrees in EE, ME, or Physics, may qualify you for a rewarding career at North American Aviation, in one of these fields:

Flight Control Analysis, Reliability Analysis, Flight Simulation, Systems Analysis.

Electrical Systems Analysis and Design, Mission and Traffic Control, Fire Control, Bombing Systems, Electronics Systems Integration, Flight Controls, Ground Support Equipment, Airborne and Electronic Test Equipment.

Applied Research in Radome Development, Antenna Development, Infrared, and Acoustics.

Please write to: Mr. G. H. Stevenson, Engineering Personnel, North American Aviation, Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

Your tooling resin formulator can help you

In an ever-widening range of production applications, tools and dies made with Epon resin-based formulations are giving outstanding service . . . and providing considerable savings compared to the cost of conventional tooling.

If you are concerned about the high cost of conventional tooling—your tooling resin formulator will show you how to get the most out of durable, impact-resistant Epon resin tools. His skill and knowledge, combined with Shell Chemical's years of experience and research, can mean more profitable production for *you*.

High-temperature tooling. Both metal and plastic forming tools, capable of operating at temperatures between 400°F. and 500°F., can be made with Epon 1310.

Long-lasting metal forming tools. Test results show that a casting of an Epon resin formulation mounted in a crank press and subjected to repeated blows had no permanent deformation after 28,000 cycles.

Excellent tolerances. Little machining and handwork are required to finish Epon resin tools, because the material can be fabricated to very close tolerances.

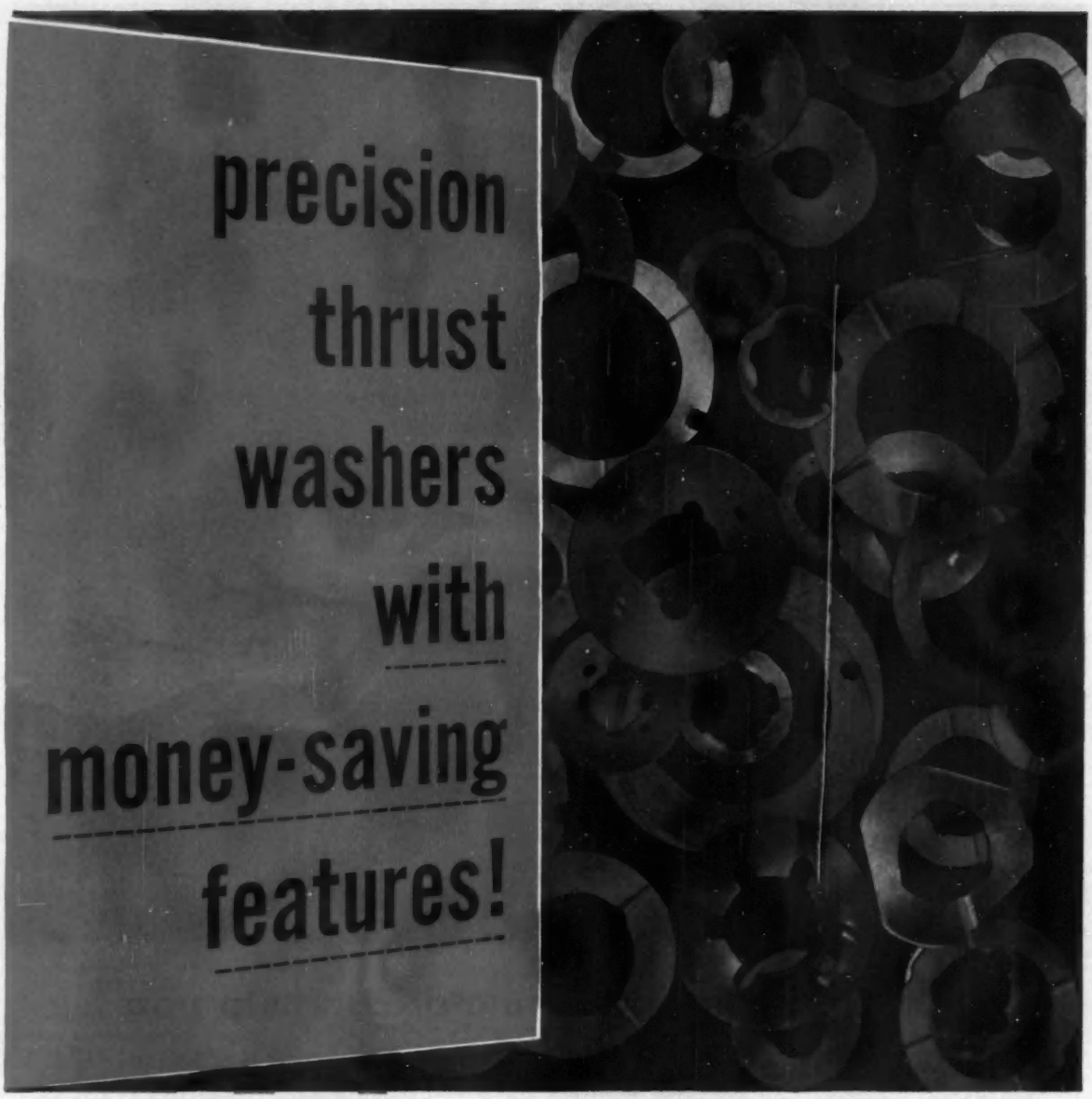
Outstanding strength. Tools with thin cross sections can be laminated with layers of glass cloth and Epon resin to achieve high flexural strength, and dimensional stability.

Can Epon resin help you with your tooling? Find out now by writing your tooling resin formulator. For a list of tooling resin formulators and further information on Epon resin, write to Shell Chemical.

SHELL CHEMICAL CORPORATION
CHEMICAL SALES DIVISION

Atlanta • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • Newark • New York • San Francisco • St. Louis
IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Montreal • Toronto • Vancouver

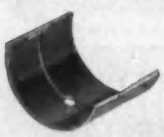
SHELL



Copper-alloy bearing surface on one or *both* faces of cold rolled steel. Slots, nibs, lugs to your design. Coined oil grooves—*no* costly machining. Write for the money-saving facts:

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11035 SHOEMAKER, DETROIT 13, MICHIGAN



Copper-Alloy Lined

Spacer Tubes

Aluminum or Babbitt Lined

Plain & Bimetal Split Bushings

FEDERAL Mogul SINCE 1899

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

New Members Qualified

Continued

sell Hanson (A), Richard D. Rogerson (A), Daniel P. Shedd (M).

St. Louis Section

Fred E. Boesch (J), George A. Busso (M), Jack D. Dudley (M), R. W. Filkey, Jr. (J).

San Diego Section

Stanley P. Merritt (A), Robert S. Myers (A), Marshall G. Richards (A).

Southern California Section

Ray H. Hahn (M), Richard H. Khuen (M), David Wade Linder (M), Olov Modig (M), James M. Seymour (A), C. H. Stevenson (M).

Southern New England Section

Walter A. Schlegel (M), Wayne Stone (M), John H. Zabel, Jr. (M).

Texas Section

Robert H. Free (A), D. M. Grisby (A).

Twin City Section

Archer W. Brown (M).

Virginia Section

Roger P. Baird, Jr. (M), Carroll Spencer Winn (A).

Outside Section Territory

Erwin E. Bircher (A), Talton Daniel Cox (M), Harvey J. Crane, Jr. (A), Robert Earl Prunty (M), Ross J. Seymour (A).

Foreign

Burley Francis Caunt (M), England; George Court (M), Brazil; Gunnar Ljungstrom (M), Sweden; Dataram V. Ramanarasu (J), India; R. Srinivasan (J), So. India; Drago F. Volowsek (M), Argentina.

Applications Received

The applications for membership received between June 10, 1958 and July 10, 1958 are listed below.

Canadian Section

Gordon A. Ferguson, James C. Mitchell, Edwin J. Nugent, George F. Plummer, Bruce C. Sibbald, Donald G. Sippel

Cleveland Section

Fred A. Alger, Richard A. Erb

Colorado Group

Ronald James Steen

Dayton Section

Wayne F. Korn

Detroit Section

Anthony L. Barclae, Robert W. Chamberlain, Wendell R. Dance, Arthur E. Ellis, Otto Alfred Ludecke, Raymond A. McCarroll, Dudley Lisle McCully, John McDougall, W. G. Northrup, Raymond Norman Okonski, Norman Revenaugh, Irving J. Rock, William J. Ronan, Joseph Dennis Ryan, John F. Skiff, Jr., Lauren H. Wells, Fred N. Zinnbauer

Indiana Section

Nolan Gerald O'Byrn, Richard Wayne Paxson

Kansas City Section

L. S. Myers, H. H. White

Metropolitan Section

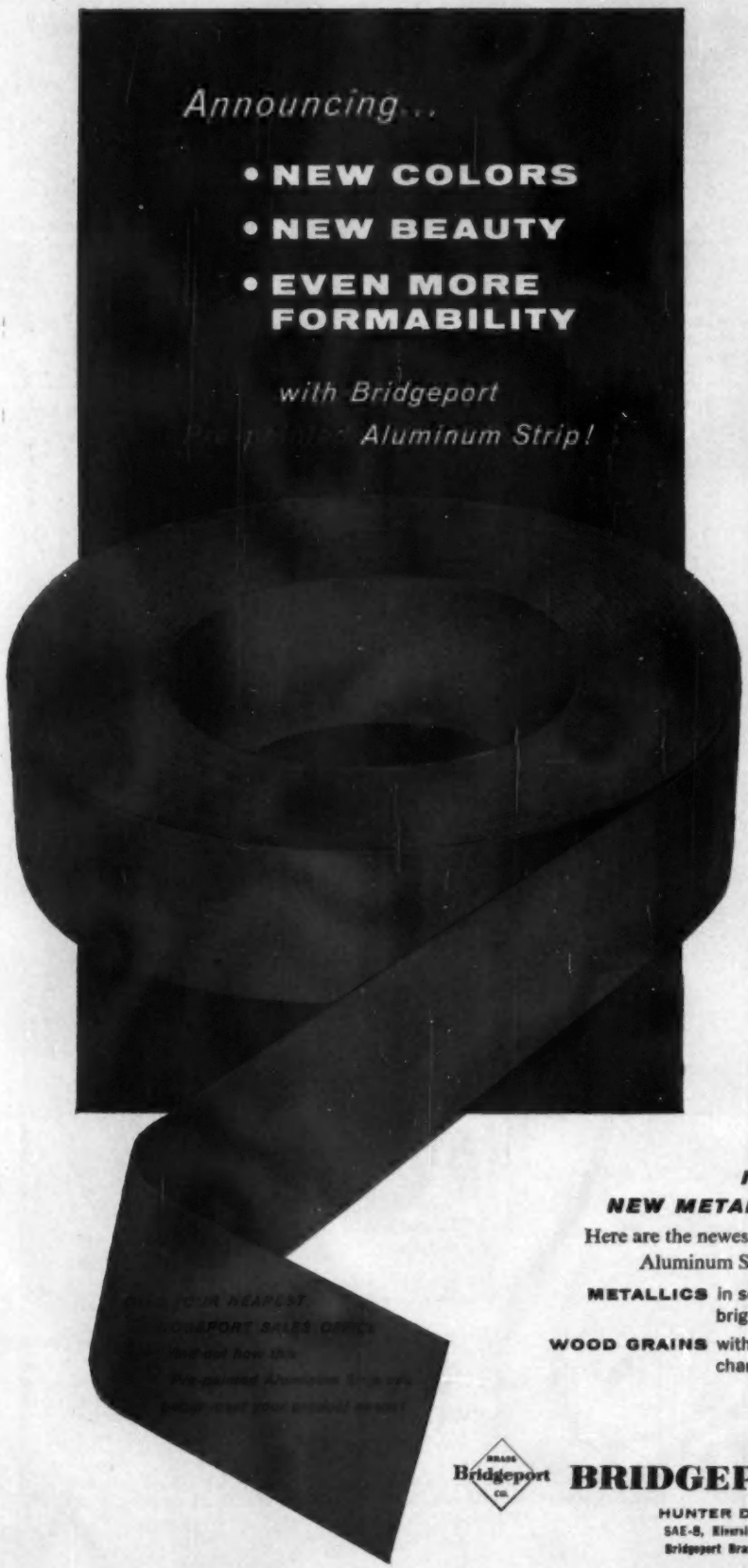
Philipp Adolf, Italo Artus-Martinelli, William Schroeder, John E. Thomas, Seymour H. Weiss

Mid-Michigan Section

Arthur Dalasinski, Walter J. Freiberg

Continued

Dual
VISION-AID HEADLAMPS
TUNG-SOL ELECTRIC INC.
NEWARK 4, NEW JERSEY
Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Melrose Park, Ill.; Irvington, N. J.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Montreal, P. Q.



Bridgeport Pre-painted Aluminum Strip is downright unique! Mirror smooth surfaces possess unusual hardness, are wear-resistant and virtually scuff-free during all forming operations. The special 2 coat finish utilizes a remarkable primer bonded tightly to the metallic surface. It strengthens the final coat, eliminates chipping, and insures maximum density and uniformity of color. Corrosion creep is simultaneously inhibited—even along metallic edges exposed in punching or shearing.

Bridgeport Pre-painted Aluminum Strip eliminates painting, insures a *superior* finish *without* finishing costs ...is proved by billions of feet now in worldwide use on Flexalum Venetian Blinds and exterior awnings. *Here is the ultimate in long lasting, exterior durability, resistance to chemical attack, sun, salt spray, wind and rain!* Now available in an almost unlimited range of sun-fast colors for a wide variety of applications.

For more beauty—for maximum formability use Bridgeport *Pre-painted* Aluminum Strip!

NOW AVAILABLE
NEW METALLICS AND WOOD GRAINS!

Here are the newest developments in Bridgeport Pre-painted Aluminum Strip designed to attract and please!

METALLICS in soft pastel colors, two finishes—glossy bright and satin sheen.

WOOD GRAINS with remarkable authenticity, lending new charm and attraction to indoor trim!

BRIDGEPORT ALUMINUM

HUNTER DOUGLAS ALUMINUM DIVISION
SAE-8, Riverside, California • Telephone OVerland 3-3030
Bridgeport Brass Company, Sales Offices in Principal Cities

Applications Received

Continued

Milwaukee Section

John William Bock, Norman Vern Denney, John Stuart Eid, Thomas M. Garvey, Ronald R. Hammett, James McLaren, Richard Rademacher

Montreal Section

Frank P. Lalonde, Jr.

Northern California Section

Frank S. Larrowe

Philadelphia Section

John J. Plomer, Julius Samuel, David Wayne Steltz

Pittsburgh Section

Pete Christy

St. Louis Section

John B. Balducci, Nick H. Eckerle, John H. Rohlfs

Salt Lake Group

Foss B. Sessions

San Diego Section

Cesar Luis Fernandez-Graziosi

Southern California Section

D. E. Butler, John A. Kenworthy, Tage Gosta Teodor Karlsson, Arthur W. Miller, Ronald Van Delden

Southern New England Section

Jesse Gould Haymes, Jr.

Spokane-Intermountain Section

Jno H. Turner

Syracuse Section

John Patrick Paling

Texas Section

David P. Allen, William J. Bramley, Emil E. Friberg, James Michael Nedzbala

Texas Gulf Coast Section

Jerry Stephen Graul

Western Michigan Section

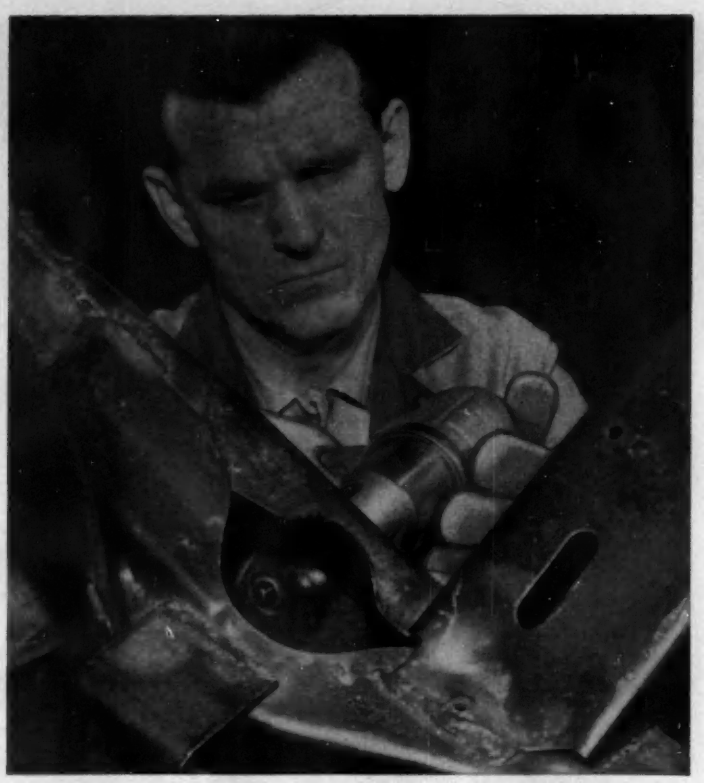
Charles G. Brokowsky, Anastasios S. Halkides

Outside of Section Territory

W. B. Haas, Noah M. Norman, Bert C. Ovesen, John S. Phelps

Foreign

Gaudenzio Bono, Italy; Rowland Slater Guy, England; Claude Leon Raymond Renondin, France



Specify MIDLAND

WELDING NUTS

for those hard-to-reach spots

Whether you're designing or fabricating, check your fastenings. Are they in hard-to-reach places? Does assembly take two men? Those are the spots for Midland Welding Nuts.

Midland Welding Nuts take seconds to apply, yet they save hours in assembly time. And, they're a better fastener. Spot welded into place for the life of the product, Midland Welding Nuts can't come loose or cause annoying rattles.

Want cost and time-saving tips? Send for the free booklet showing you how to "Save with Midland Welding Nuts."

MIDLAND-ROSS CORPORATION

WELD NUT DIVISION

6660 MT. ELLIOTT AVENUE • DETROIT, MICHIGAN

From fly-wheel to drive-wheel
. . . let it be CLARK

There's no finer assurance of a long and profitable life for a revenue vehicle than Clark units delivering horsepower from fly-wheel to tires. That basic usefulness extends with equal effectiveness to stationary power plants.

It's a distinguished family of proved money-makers—every one a product of planned specialization in this vital area of power transmission; every one solidly proved by millions of low-cost miles.

See our product line at Booth No. 9
SAE Engineering Display
Milwaukee Auditorium
September 8-11

CLARK® EQUIPMENT

CLARK EQUIPMENT COMPANY
BUCHANAN 5, MICHIGAN

Design for Beauty, Work, and Wear with Armco Stainless Steels

Armco Stainless Steels lend dash and beauty to corrosion-resisting automotive trim, give strength and durability to hard-working mechanical parts.

It's easy to match specifications because Armco Stainless sheets, strip, bars, and wire are produced in the exact analyses, finishes, and sizes required for automotive use. Quality is uniform from order to order.

For the future . . .

It may also pay you to consider stainless steel when ordinary materials won't meet the exacting demands of advanced styling and improved mechanical design. Some of Armco's more-than-50 standard and special stainless steels may be ready-made solutions.

For stainless *now*, call the Armco Sales Office nearest you. If you're considering stainless steel for a new application, fill in and mail the coupon.

ARMCO STEEL CORPORATION, 2628 Curtis St., Middletown, Ohio

New steels are born at Armco

What Armco Stainless grade do you recommend for _____?

(application)

NAME _____ TITLE _____

FIRM _____

STREET _____

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ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Studebaker-Packard recommends Sealed Power

KromeX Piston Ring Sets

with new, exclusive stainless steel oil ring

Studebaker-Packard dealers everywhere can now provide famous Sealed Power KromeX Piston Rings for replacement service. These outstanding KromeX Ring Sets are especially designed, tested and approved to match the thrilling performance and reliability engineered into the great Studebaker-Packard power plants.

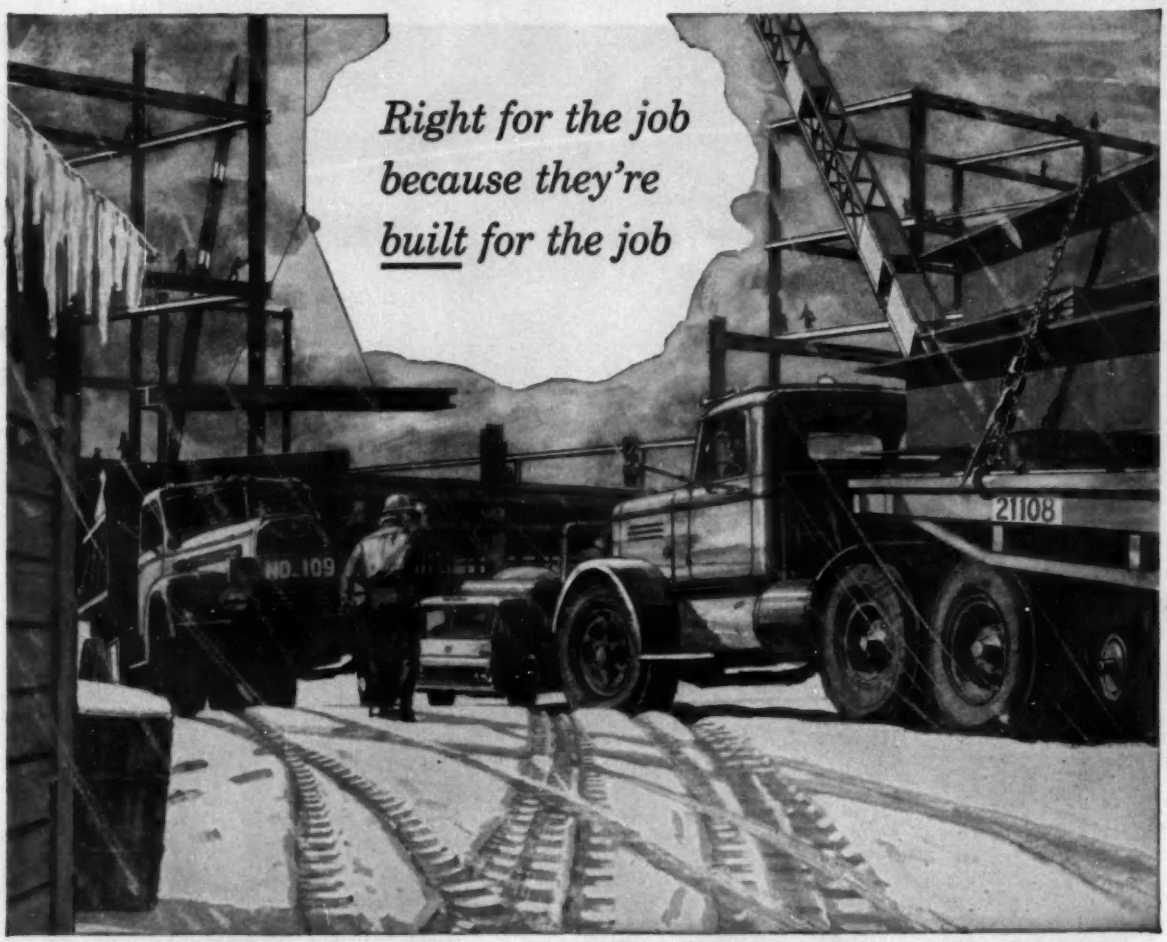
TESTED AND APPROVED

S·P SUPERIOR PERFORMANCE Guaranteed

PRECISION BUILT PRODUCTS

Parts and Accessories Division

STUDEBAKER-PACKARD CORPORATION



EVANS HEATERS ARE RIGHT FOR TRUCKS BECAUSE THEY'RE BUILT FOR TRUCKS

It goes without saying that your truck has to be *truck built* all the way through. Including the heater!

You'll find *every* Evans heater is *truck built*. Each is designed to meet the specific heat and installation requirements of the type truck it is to serve. This means both correct BTU output *and* proper heat distribution ... something a warmed-over car heater cannot provide.

It also means longer heater life. To prove it, Evans backs every heater with a parts "repair or replace" warranty good for a full year or 50,000 miles, whichever occurs first.

EVANS PRODUCTS COMPANY

PLYMOUTH, MICHIGAN

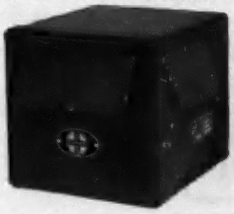
An Evans heating engineer will be happy to work with you in solving *your* truck heating problems. Write for complete information: Evans Products Company, Dept. Z-8, Plymouth, Michigan.

Regional Representatives: Cleveland, Frank A. Chase
Chicago, R. A. Lennox Co., Inc.; Detroit, Chas. F. Murray Sales Co.
Allentown, Pa., P. R. Weidner

EVANS PRODUCTS COMPANY ALSO PRODUCES:

railroad loading equipment; bicycles and velocipedes; Evaneer® fir plywood; fir lumber; Evanite® battery separators; Evanite® hardboard; Haskelite doors; Evanite Plywall.

EVANS



New extreme-high-temperature lubricants for missiles and supersonic aircraft **SHELL ETR GREASES**

One of the serious lubricating problems faced by designers of missiles and supersonic aircraft has been solved by scientists at Shell Research Laboratories.

The problem: to find a grease which would permit components to operate with certainty under extreme high temperatures. Co-operation with representatives of bearing manufacturers and military personnel resulted in a completely new class of greases—SHELL ETR GREASES.

These greases can easily withstand temperatures up to 600°F. They give superior lubricating performance because of a special thickener—an organic vat dye—which has exceptional heat stability and jelling efficiency.

If you are presently in the market for an ultra-high-temperature-range grease, we will be glad to provide more information on Shell ETR Greases.

SHELL OIL COMPANY

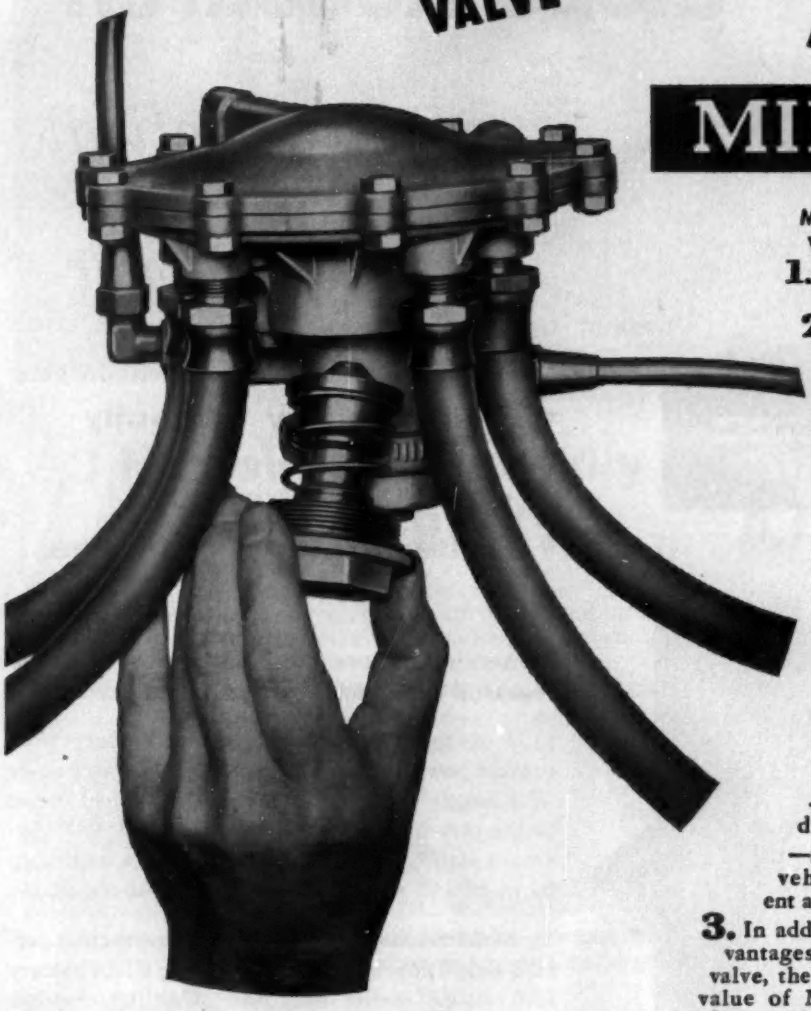
50 West 50th Street, New York 20, N.Y.
100 Bush Street, San Francisco 6, Calif.

SHELL

IF YOU OPERATE TRUCK-TRAILERS YOU NEED THE BEST EMERGENCY RELAY VALVE YOU CAN BUY . . .

AND THAT'S

MIDLAND



Midland's New Emergency Relay Valve Is Best For You Because—

1. It gives you 100% protection against "bleed-back".

2. It goes beyond ICC requirements—gives you many PLUS features like these:

—**Midland** valve can be quickly, easily serviced. You can remove and replace cartridge in a matter of minutes, *without disconnecting any lines or fittings.* (*See photo.*)

—**Operation** of Midland valve is automatic, yet *gradual.* (Automatic application of trailer brakes is *instantaneous,* of course, if trailer separates from tractor.) Valve's dual compensating feature provides automatic, gradual application of trailer brakes if pressure in the system drops below 45 p.s.i.

—**Midland** valve is designed to reduce application and release time.

—**Midland** valve safeguards against vehicle driveaway without sufficient air in the system.

3. In addition to the actual operating advantages of Midland's emergency relay valve, there's the protection and dollar value of Midland's nation-wide service and parts facilities—hundreds of Midland distributors in the United States, Canada, and abroad.

Be safe, be satisfied—specify Midland Emergency Relay Valves on all orders of new equipment.

M-R

MIDLAND-ROSS CORPORATION

OWOSSO DIVISION • OWOSSO, MICHIGAN

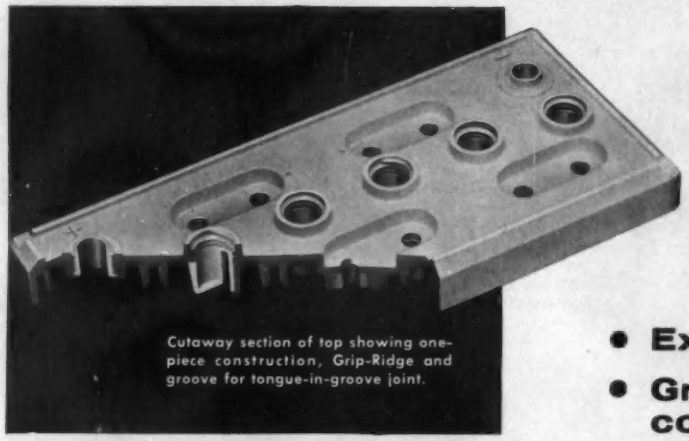
Export Department: 38 Pearl Street, New York, N.Y.

The Only Complete Line of Braking Equipment

POWER MIDLAND BRAKES

to GLOBE RESEARCH no battery is ever perfect

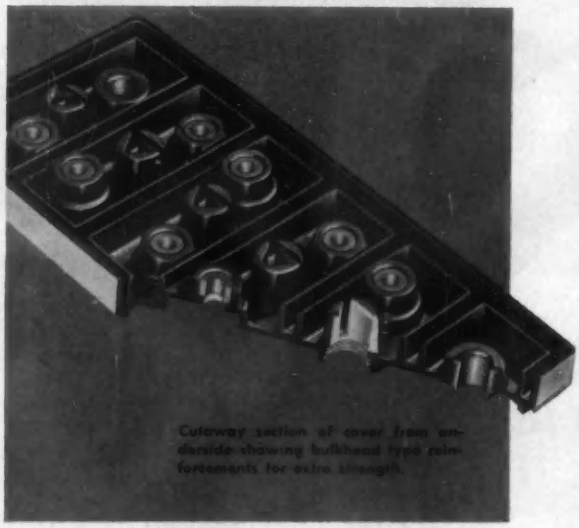
from Globe Research



Cutaway section of top showing one-piece construction, Grip-Ridge and groove for tongue-in-groove joint.

first practical one-piece battery cover for

- **Extra battery capacity**
- **Greater all-over container strength**
- **Better looking batteries**



Cutaway section of cover from underside showing bulkhead type reinforcements for extra strength.

Globe Spinning Power Batteries are now available for fast, low-cost shipment from 16 strategically located plants—15 (*) now producing dry-charged batteries:

*ATLANTA, GA., *DALLAS, TEXAS, *EMPORIA, KANSAS, *HOUSTON, TEXAS, *LOUISVILLE, KY., *MEDFORD, MASS., *MEMPHIS, TENN., *MILWAUKEE, WIS., *MINERAL RIDGE, OHIO, *PHILADELPHIA, PA., *REIDSVILLE, NO. CAROLINA, *SAN JOSE, CALIF., *HASTINGS-ON-HUDSON, NEW YORK, *LOS ANGELES, CALIF., OREGON CITY, ORE., *TAMPA, FLA.

Pioneering the one-piece battery cover, Globe research achieved two significant advances:

1) A stronger, better performing battery with broader power range and longer life. One-piece cover with tongue and groove construction is weld-sealed to the case to make one inseparable unit. Cell partitions and container are reinforced like a battleship to withstand extreme heat and road-shock abuse.

2) More merchandisable battery. Construction permits Grip-Ridge for quickly anchoring Globe battery into battery carrier (any size). Unitized case has modern styling, permits painting in vivid color combinations for trade-up eye-and-buy appeal.

Globe research — as it has for over 30 years — continues to develop battery design advantages like these, which benefit both the original equipment manufacturer and the service industry.

SPINNING POWER GLOBE-UNION SPLIT-SECOND STARTING

GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

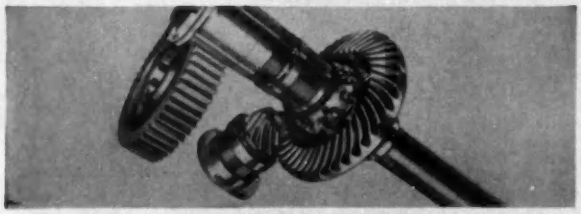
If it's Petroleum-powered there's a GLOBE-BUILT BATTERY right from the start!

*18-ton payloads are moved by four Allis-Chalmers Mfg. Co. TS-260 motor scrapers. Ni-Cr-Mo steels help make their drives rugged.

3 Nickel-chrome-moly steels give drives the strength to move mountains

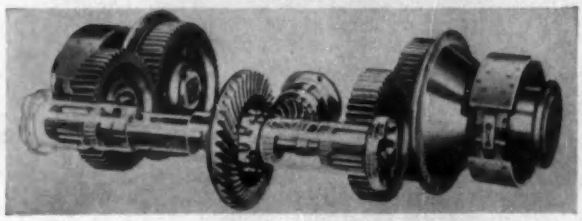
Drives for the Allis-Chalmers 20-ton "mountain" moving scrapers* are made for heavy duty . . . made with 3 outstanding nickel-chromium-molybdenum steels . . . steels that may well provide just the end properties and processing behavior you're going after.

FOR SPIRAL RING GEAR AND BEVEL PINION . . . AISI 4320



These heaviest duty gears need 4320 to give a combination of great strength and toughness and high wear resistance. Carburized and hardened this steel develops a high core strength in heavy sections, along with a tough wear resistant case.

FOR DIFFERENTIAL SPIDERS, SIDEGEARS, BEVEL PINION . . . AISI 8620
FOR FINAL DRIVE BULL GEARS, IDLERS, PINIONS . . . AISI 8627



They are economical in cost and processing with the ability to develop adequate strength in medium sections with 8620 and heavier sections with 8627.

NICKEL MAKES ALLOYS PERFORM BETTER LONGER. If you are looking for the best steel to suit your particular engineering and economic requirements, consider the nickel-containing steels. Inco's D & R div. has helpful information on regular and new steels. We will be glad to make it available to you, just write.

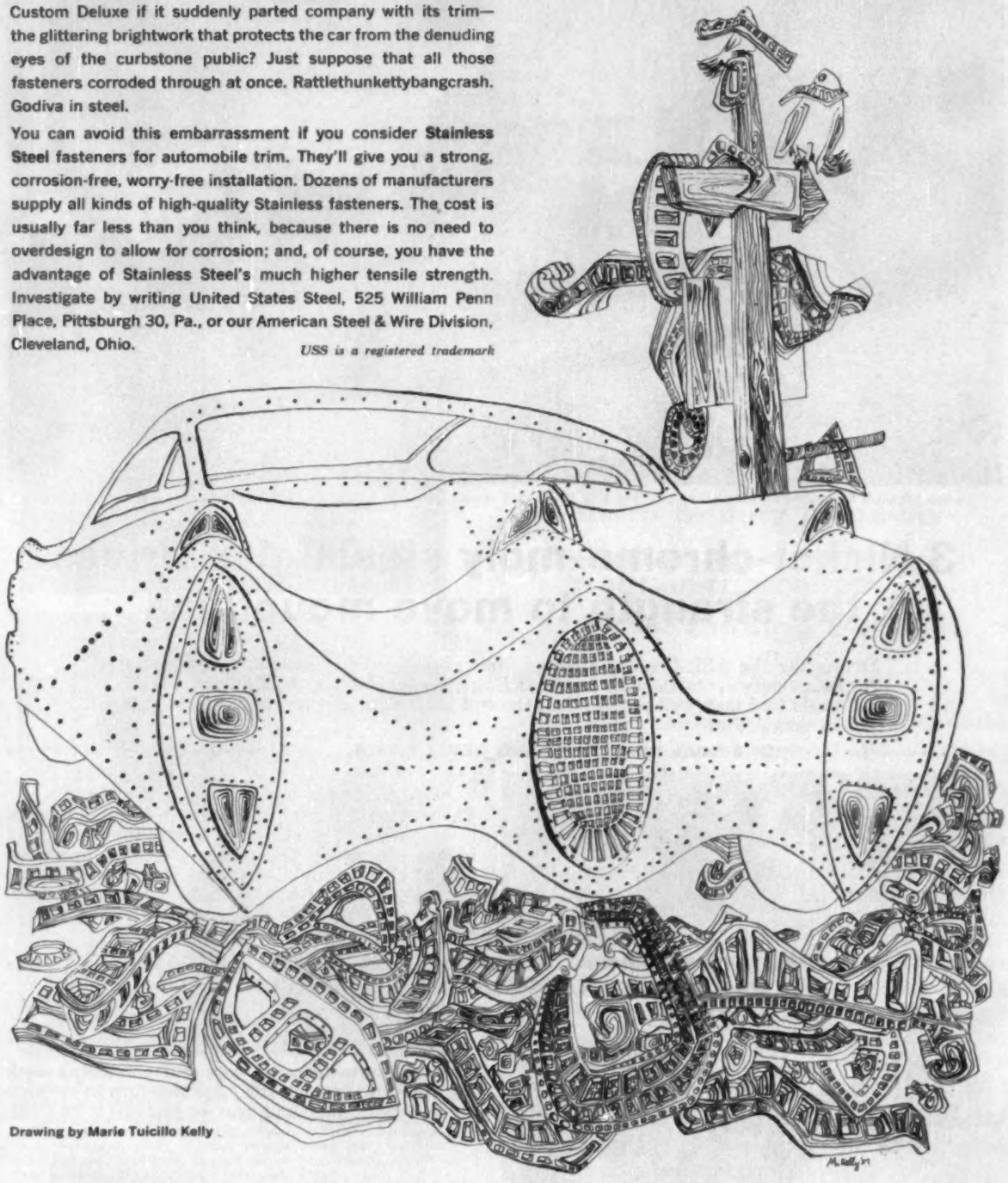
THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y. **INCO NICKEL**

The day the trim fell off

Could you imagine the shy, naked look of a 1958 Sleekaire Custom Deluxe if it suddenly parted company with its trim—the glittering brightwork that protects the car from the denuding eyes of the curbstone public? Just suppose that all those fasteners corroded through at once. Rattlethunkettybangcrash. Godiva in steel.

You can avoid this embarrassment if you consider **Stainless Steel** fasteners for automobile trim. They'll give you a strong, corrosion-free, worry-free installation. Dozens of manufacturers supply all kinds of high-quality Stainless fasteners. The cost is usually far less than you think, because there is no need to overdesign to allow for corrosion; and, of course, you have the advantage of Stainless Steel's much higher tensile strength. Investigate by writing United States Steel, 525 William Penn Place, Pittsburgh 30, Pa., or our American Steel & Wire Division, Cleveland, Ohio.

USS is a registered trademark



Drawing by Marie Tuicillo Kelly

United States Steel Corporation–Pittsburgh
American Steel & Wire–Cleveland
Columbia-Geneva Steel–San Francisco
National Tube–Pittsburgh
Tennessee Coal & Iron–Fairfield, Alabama
United States Steel Supply–Warehouse Distributors
United States Steel Export Company

USS **United States Steel**

High Grade Machines Deserve MECHANICS *Roller Bearing* UNIVERSAL JOINTS Quality

Your high grade machines deserve MECHANICS Roller Bearing UNIVERSAL JOINTS high quality. And now you can benefit from the protection and convenience of "once-a-season" or "lifetime" lubricated *roller bearing* universal joints—and still have the economy of stamped yoke construction. Let our engineers show you how this new MECHANICS Roller Bearing UNIVERSAL JOINTS development will give your machines competitive advantages.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

MECHANICS UNIVERSAL JOINT DIVISION

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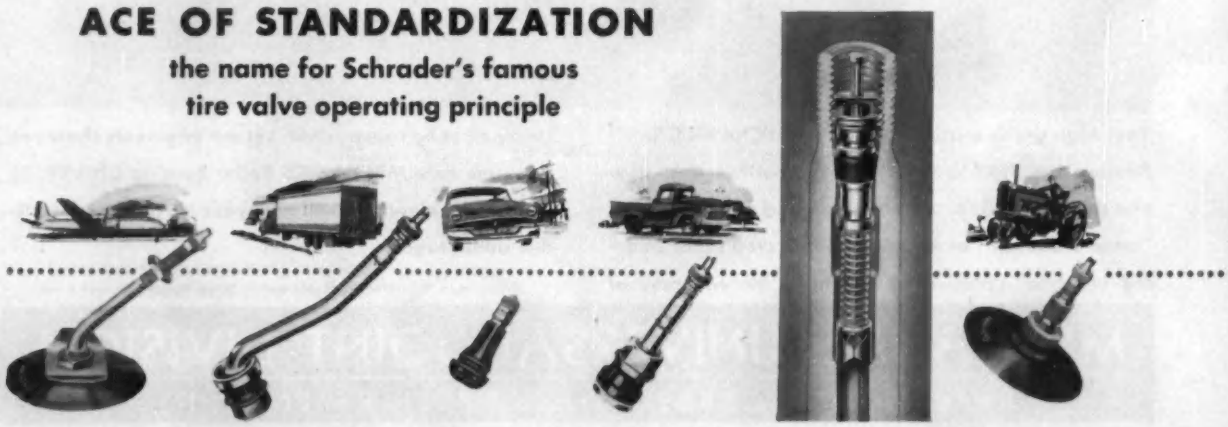
ANYWHERE IN THE WORLD...ANYONE

ACE OF STANDARDIZATION

the name for Schrader's famous tire valve operating principle



CAN AIR-SERVICE TODAY'S TIRES

years of tire valve standardization make it easy

On the other side of the world, servicemen are using the same American tools, parts and methods to service vehicles as the man in the station down the block. Tire service is fast and easy because of standardization, but this situation didn't just happen. The U. S. Automotive, Tire and Tire Valve Industries combined their skills and experience not only to maintain highest quality while mass producing at lowest cost, but to produce interchangeable air valves and tools that make service possible anywhere a vehicle goes. Schrader's job is to utilize all the Industry know-how and produce the safest, most practical and dependable valves for all types of pneumatic tires.

Count on quality Schrader Tire Valves to match the performance of your vehicles . . . because the "Ace of Standardization" design can be serviced anywhere in the world.

Schrader®
a division of SCOVILL

A. SCHRADER'S SON • BROOKLYN 38, N. Y.
Division of Scovill Manufacturing Co., Inc.

FIRST NAME IN TIRE VALVES

FOR ORIGINAL EQUIPMENT AND REPLACEMENT

Check up! Are the brake systems you offer as safe as they should be?

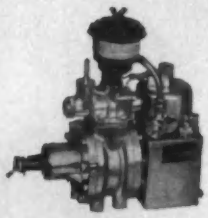
Wagner
AIR BRAKE COMPONENTS

help increase safety and reduce truck operating costs

How do your brake systems rate? Wagner Air Brake Systems and components can help make your vehicles safer to operate, reduce "down time" and truck operating costs, build customer satisfaction.

Wagner offers a complete line of original equipment for air brakes and control systems. It includes rotary air compressors, brake application valves, vehicle protection valves, brake actuating units, moisture ejection valves, warning devices, air tanks, tractor-trailer hose couplers, air line hoses and air line connectors.

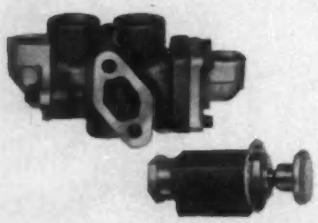
Wagner Air Brakes are the product of more than thirty-five years of brake engineering experience—gained in the designing and building of brake systems and brake parts for the automotive industry. When you equip the heavy-duty vehicles you manufacture with Wagner Air Brakes, you are adding safety and low-maintenance features that build customer acceptance.



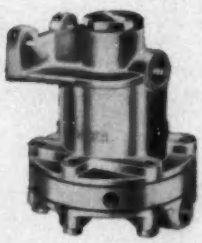
ROTARY AIR COMPRESSORS are available in either 9 or 12 C. F. M. capacity. These Wagner Compressors have fast air recovery to assure an adequate supply of air pressure at all times. Rotary motion reduces vibration. Oil separation and cooling before air is discharged reduces temperature and prevents carbon formation.

FOOT OPERATED BRAKE APPLICATION VALVE, of the high capacity type, provides the driver with control of the vehicle brakes. It meters applied braking pressure in proportion to foot pressure exerted against brake pedal or treadle. The Wagner line also includes a HAND OPERATED APPLICATION VALVE. It provides independent control of trailer brakes.

RELAY QUICK-RELEASE VALVE controls the brakes on specific axles, acting in unison with the driver-controlled application valve. It automatically meters pressure directly from tank, speeding normal brake application and release. The relay valve is particularly suitable for the rear axles of long wheelbase vehicles.



TRACTOR PROTECTION and EMERGENCY BRAKE VALVES constitute a combination of two valves installed on the tractor. The emergency brake valve is a manual triggering unit for emergency braking the trailer and for actuating the tractor protection valve. The protection valve seals the tractor air lines.



MOISTURE EJECTION VALVE is fully automatic, operating in the 15-25 psi pressure range. Normal brake applications operate the valve, keeping reservoir clean and moisture-free. Expulsions occur without a notable drop in gauge pressure. Prevents accumulation of moisture or sludge in air tank.

LOW PRESSURE INDICATOR—buzzer or lamp—warns the driver of air braked vehicle if air pressure is below the safe driving range. In use, the warning circuit is controlled by a pneumatic switch which also is connected to the pressure side of the air brake system. Unit automatically closes the circuit if pressure drops below predetermined value.

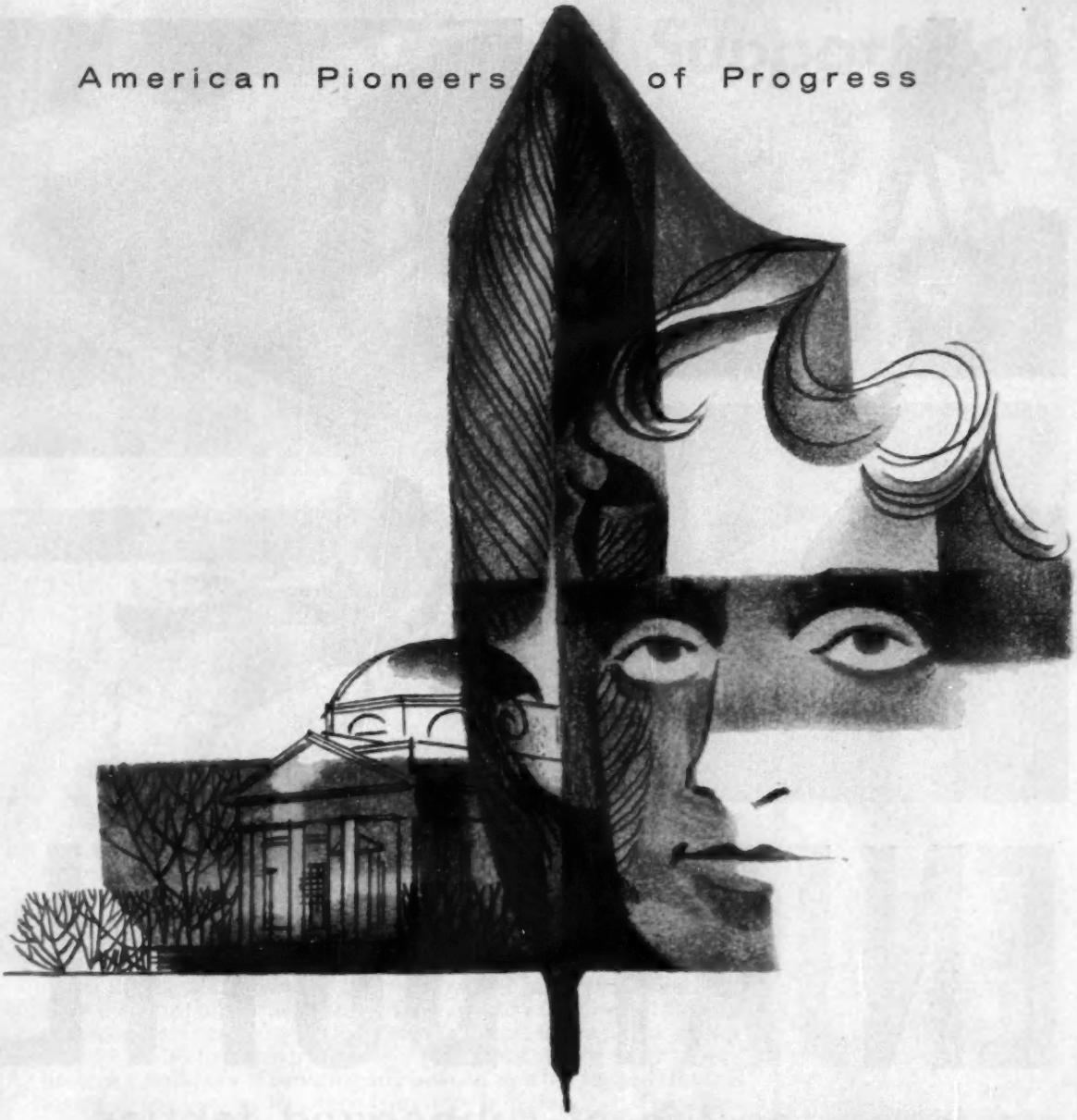
Wagner Air Brake Systems and Air Brake Components for trucks, tractors, trailers, buses, and off-the-road equipment are fully described in CATALOG KU-201. Write today for your free copy.

WK58-6

Wagner Electric Corporation 6378 Plymouth Avenue, St. Louis 14, Missouri, U. S. A., *(Branches in principal cities in U. S. and in Canada)*

LOCKHEED HYDRAULIC BRAKE PARTS, FLUID and BRAKE LINING • AIR HORNS • AIR BRAKES • TACHOGRAPHS • ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES

American Pioneers of Progress



I LIKE THE DREAMS
OF THE FUTURE
BETTER THAN THE HISTORY
OF THE PAST.

THOMAS JEFFERSON

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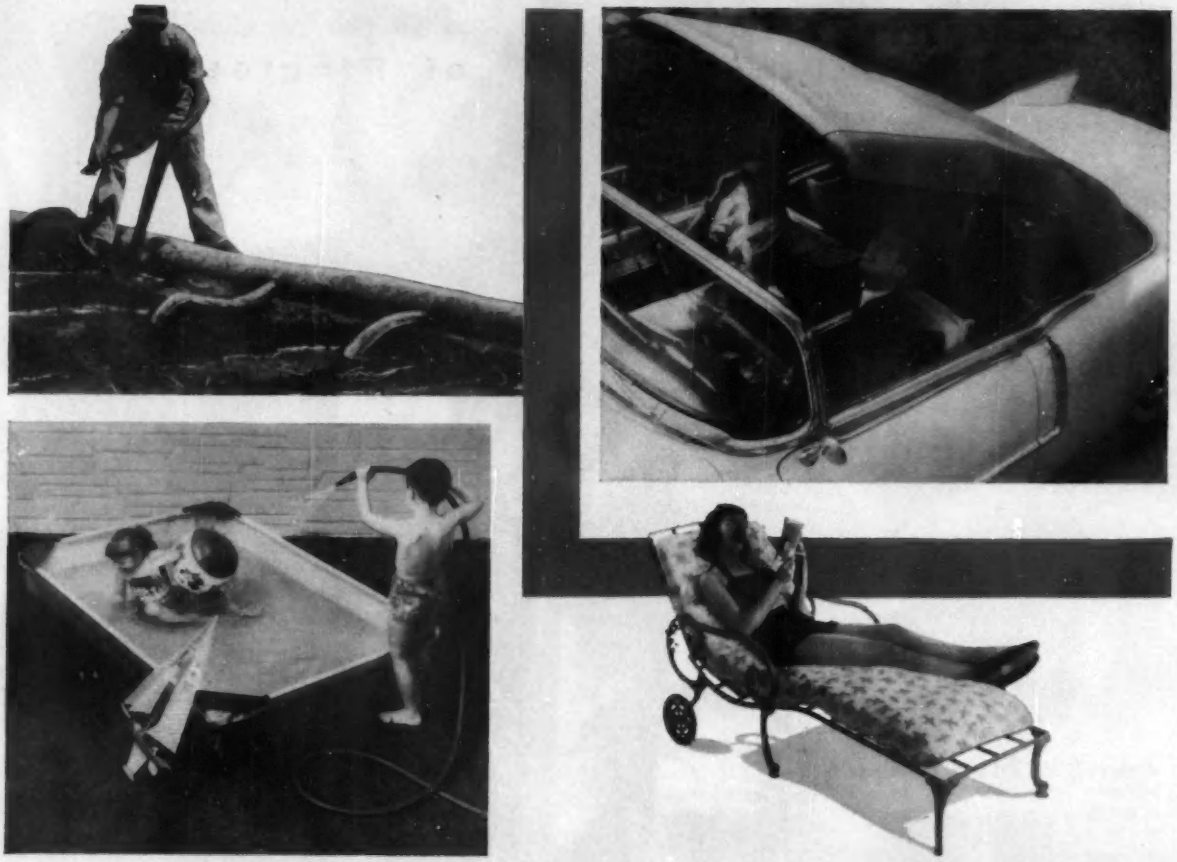
DIVISION OF ACF INDUSTRIES, INCORPORATED • ST. LOUIS 7, MISSOURI



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Enjay Butyl puts *extra life* in a wide variety of rubber-coated fabrics through its superior resistance to tearing, cracking and aging. Leading manufacturers of wading pools, irrigation tubing, auto tops and outdoor covers choose versatile Enjay Butyl because they know it will withstand the traditional enemies of rubber—weathering, sunlight and abrasion.

In many different applications, versatile Butyl outperforms all other types of natural or synthetic rubber. Find out how Enjay Butyl can help you cut costs . . . build more performance into your products. Contact the Enjay Company for the whole story, plus technical assistance when desired.

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Enjay Butyl is the greatest rubber value in the world. It's the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

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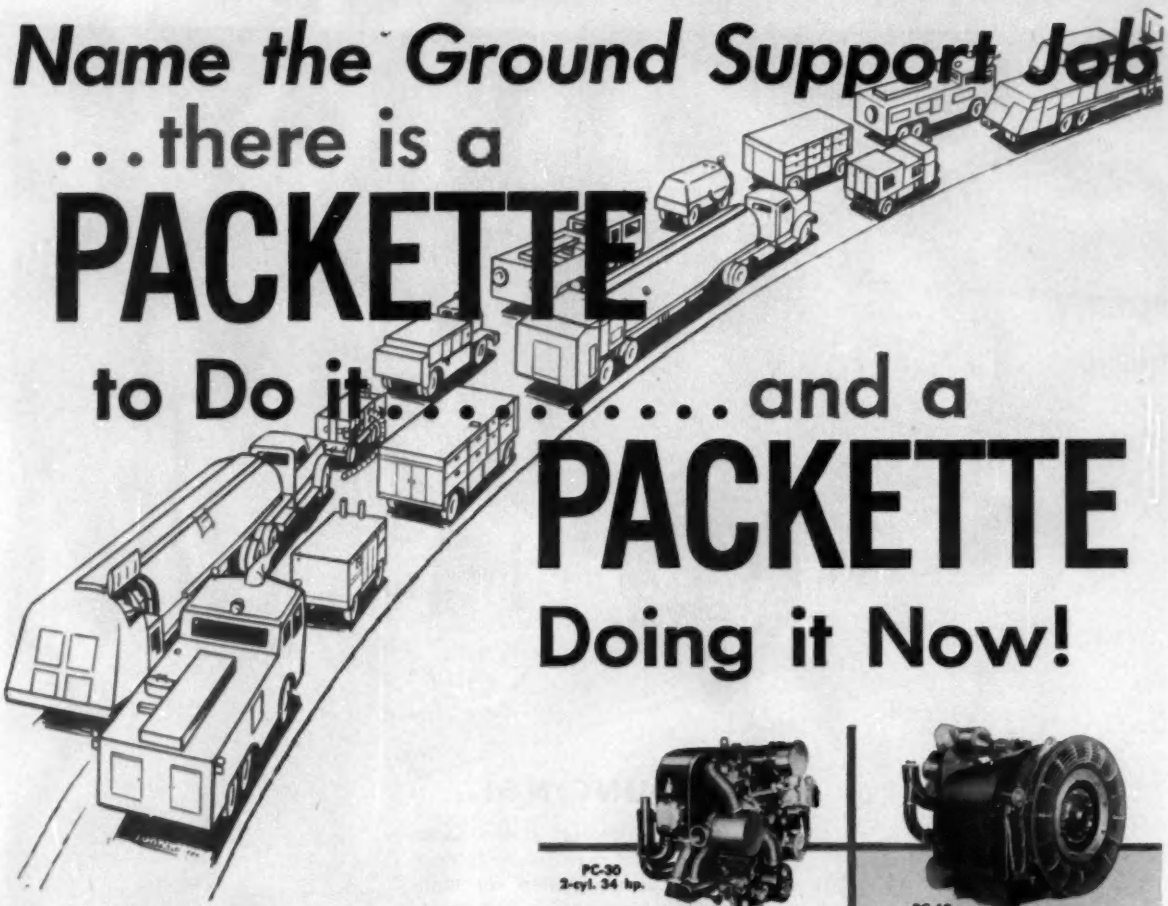
Name the Ground Support Job

...there is a PACKETTE to Do it.....and a PACKETTE Doing it Now!



Air conditioners, crash trucks, compressors, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose trucks—it would be hard to name a type of ground support equipment which one or another of the five Continental Packettes isn't either doing, or equipped to do, better than any other engine. . . . . These Military Standard power plants (Mil. E-6449-A) are approved for use in equipment for all branches of the Armed Forces. Developed by Continental Motors, on whose aircraft engine models they are based, they span an output range from 30 to 250 horsepower. They combine light weight, compactness, and ease of servicing and upkeep with the rugged stamina for which Continental has been known for 56 years. . . . . Packettes are built to operate in any temperature from sizzling desert heat to 65 below zero, power output being automatically governed to the load. They feature unusually wide interchangeability of parts—among themselves and among models in Continental's aircraft engine line—and complete supplies of parts are maintained all over the world.

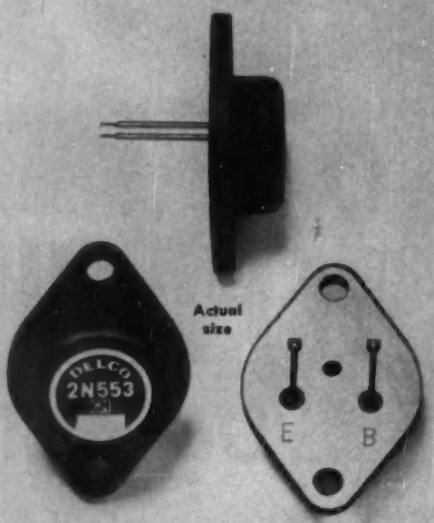
In short, IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER POWER PLANT WILL DO THE JOB SO WELL

WRITE FOR COMPLETE INFORMATION

Continental Motors Corporation

AIRCRAFT ENGINE DIVISION

MUSKEGON, MICHIGAN



ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS T = 25°C unless otherwise specified

Collector diode voltage V_{cb} (V_{eb} = −1.5 volts)	80 volts maximum
Emitter diode voltage V_{eb} (V_{cb} = −1.5 volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{co} (V_{cb} = 2 volts)	12 μa
Collector diode current I_{co} (V_{cb} = −60 volts)	0.5 ma
Collector diode current I_{co} (V_{cb} = −30 volts, 75°C)	0.5 ma
Current gain (V_{ce} = −2 volts, I_c = 0.5 amp.)	55
Current gain (V_{ce} = 2 volts, I_c = 2 amps.)	25
Saturation voltage V_{ec} (I_b = 220 ma, I_c = 3 amps.)	0.3
Common emitter current amplification cutoff frequency (I_c = 2 amps. V_{ec} = 12 volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

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726 Santa Monica Boulevard
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DELCO RADIO Division of General Motors
Kokomo, Indiana

Living room luxury on the road . . . economically . . . with

URETHANE FOAMS!

Based on NACCONATES®

Progress in urethane chemistry has now created the ultimate in seating comfort. Proof: leading names in luxurious home furnishings feature urethane foams in their fall '58 lines!

Especially suited to automotive seating, urethanes have air-cushioned comfort without "fight-back" and "side-sway." Outer coverings hug cushions—no wrinkles, no displaced welts. And urethanes have remarkable tensile and tear strength, low permanent set and resist solvents and low temperature stiffening.

The many ways urethanes can be fabricated . . . molded, foamed in place, bonded to structural frames or outer coverings, cut, sewn, tacked or hog-ringed . . . suggest new cost-saving production methods that are well worth your investigation.

As makers of NACCONATE® Diisocyanates, essential urethane components, we will gladly work on application development with automotive engineers, designers and suppliers. For information, write National Aniline.

Allied Chemical

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Akron Atlanta Boston Charlotte Chattanooga Chicago Greensboro Los Angeles
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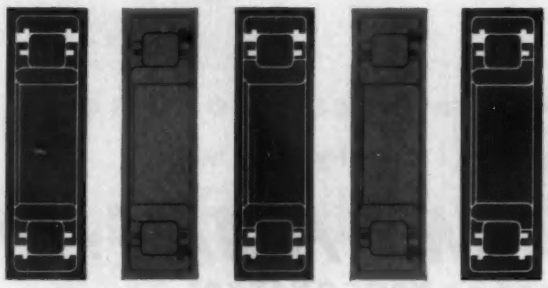
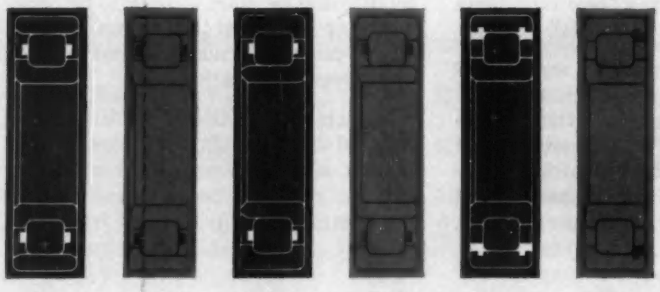
The Type UR-E Tru-Rol segmented-retainer bearing illustrated above, affords adequate precision, performance and life expectancy for most "upper range" commercial-grade applications.





Rollway Tru-Rol Bearings give you "for the job" selectivity in a wide range of applications. They approach the design, precision and quality of bronze-retainer bearings as closely as commercial grade pricing will allow. Internal clearances are close. Rollers are equally spaced to avoid out-of-balance vibration and "pulse". And each is crowned to distribute the load evenly along the full length of the roller. 11 types available in single and double width bearings, in stamped steel retainer, segmented retainer or full roller construction.

ask *a near-by Rollway Service Engineer to detail the quality you should be getting in your "commercial grade" bearings. No cost. No obligation. Write to*

ROLLWAY BEARING COMPANY, INC.
586 Seymour St., Syracuse, N.Y.
ENGINEERING OFFICES: Syracuse • Philadelphia
Boston • Chicago • Cleveland • Pittsburgh
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The MISSILE:

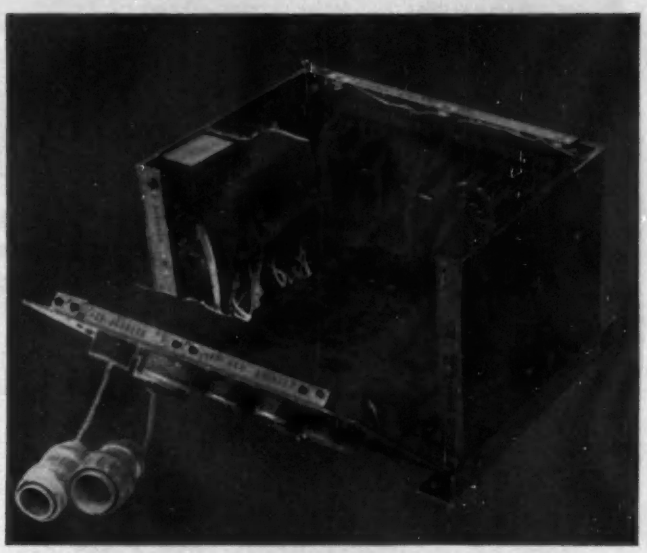
U. S. A. F. Northrop's SM-62 Snark, with a range of more than 6000 miles. Now operational, the Snark is America's first intercontinental guided missile. Powerplant is a Pratt & Whitney J-57 turbojet. Guidance is by a stellar-monitored inertial system.

The MATERIAL:

SILASTIC

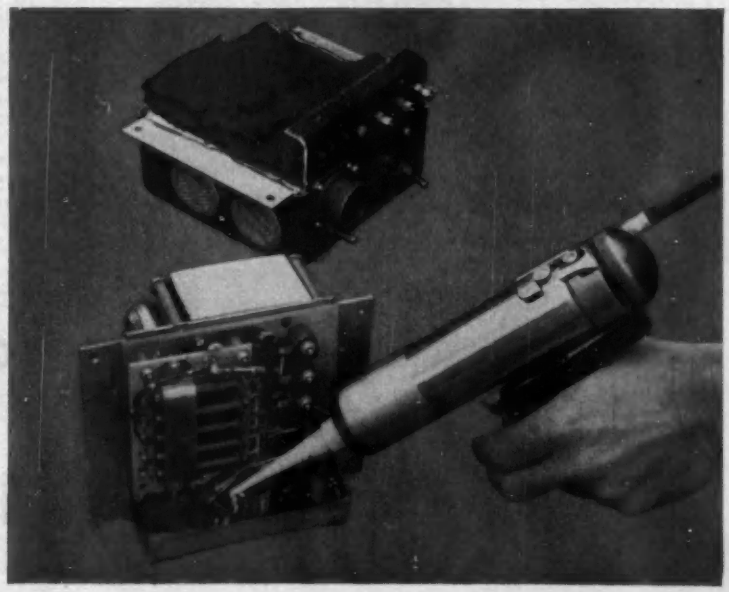
In the Snark, panels containing resistors, capacitors, transistors and other electronic components are cushioned by Silastic*, the Dow Corning silicone rubber. Silastic protects against moisture, vibration damage, electrical leakage.

*T.M.REG. U.S.PAT.OFF.



The METHOD:

Encapsulating with Silastic RTV, via calking gun. Silastic RTV vulcanizes completely at room temperature. When vulcanized, it has the characteristics typical of Silastic: resistance to extreme temperatures, moisture, ozone, corona. Electrical properties are excellent. Silastic RTV can be slit open for repair work and then re-sealed. Write for sample and technical data.



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NEW

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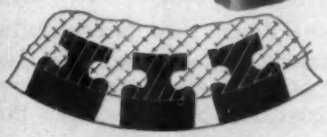
ESPECIALLY DESIGNED FOR TOP RING GROOVE PROTECTION IN PISTONS FOR GASOLINE ENGINES

AN ECONOMICAL METHOD WITH MINIMUM WEIGHT INCREASE

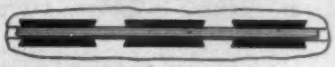
CAN BE APPLIED TO ANY TYPE ALUMINUM ALLOY PISTON

PERMA-GROOVE*

WITH SEGMENTAL STEEL TOP RING SECTION



TOP RING SECTION



FRONT VIEW SECTION

CROSS SECTION

Again, Zollner engineering leadership provides another great piston development to engine builders. The new Zollner "Perma-Groove" gives sensationally longer life to pistons and rings, prevents blow-by, minimizes oil consumption. The light weight segmental steel section incorporates high wear resistance in the top ring groove *plus* the advantage of cool operation. Designed especially for gasoline engine pistons, "Perma-Groove" is the quality, low-weight and low-cost companion to the popular "Bond-O-Loc" piston for Diesel engines. We suggest an immediate test of "Perma-Groove" advantages for your gasoline engine.

*T. M. Reg. Pat. App. For

OUTSTANDING ADVANTAGES OF ZOLLNER "PERMA-GROOVE" TOP RING SECTION

1. Individual steel segments eliminate continuous band expansion problem.
2. Segments securely locked to prevent radial movement.
3. Dovetailed edges keep steel segments securely in plane with groove.
4. 75% steel bearing area for wear resistance.
5. 25% aluminum bearing area for heat conductivity and cool operation.
6. Light in weight.

ADVANCED ENGINEERING

PRECISION PRODUCTION

COOPERATION WITH ENGINE BUILDERS

ZOLLNER PISTONS

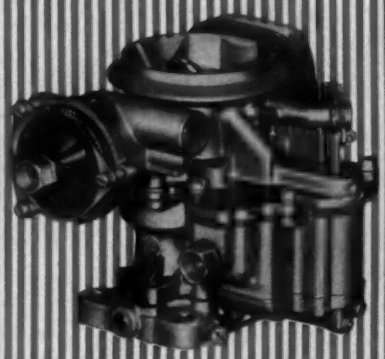
THE ORIGINAL EQUIPMENT PISTONS

ZOLLNER

ZOLLNER CORPORATION • Fort Wayne, Indiana

Foremost in economy and dependability

STROMBERG



Owner loyalty is the one priceless asset without which no car manufacturer can long survive. Loyal owners become *repeat customers* and the thing that brings them back to the same dealer, year after year, is *performance*. No single component of a car is a bigger factor in performance than the carburetor. That's why it's wise to specify Stromberg*, most reliable and economical carburetor built. The Stromberg Carburetor is built by Bendix-Elmira, first name in automotive fuel systems.

*REG. U. S. PAT. OFF.

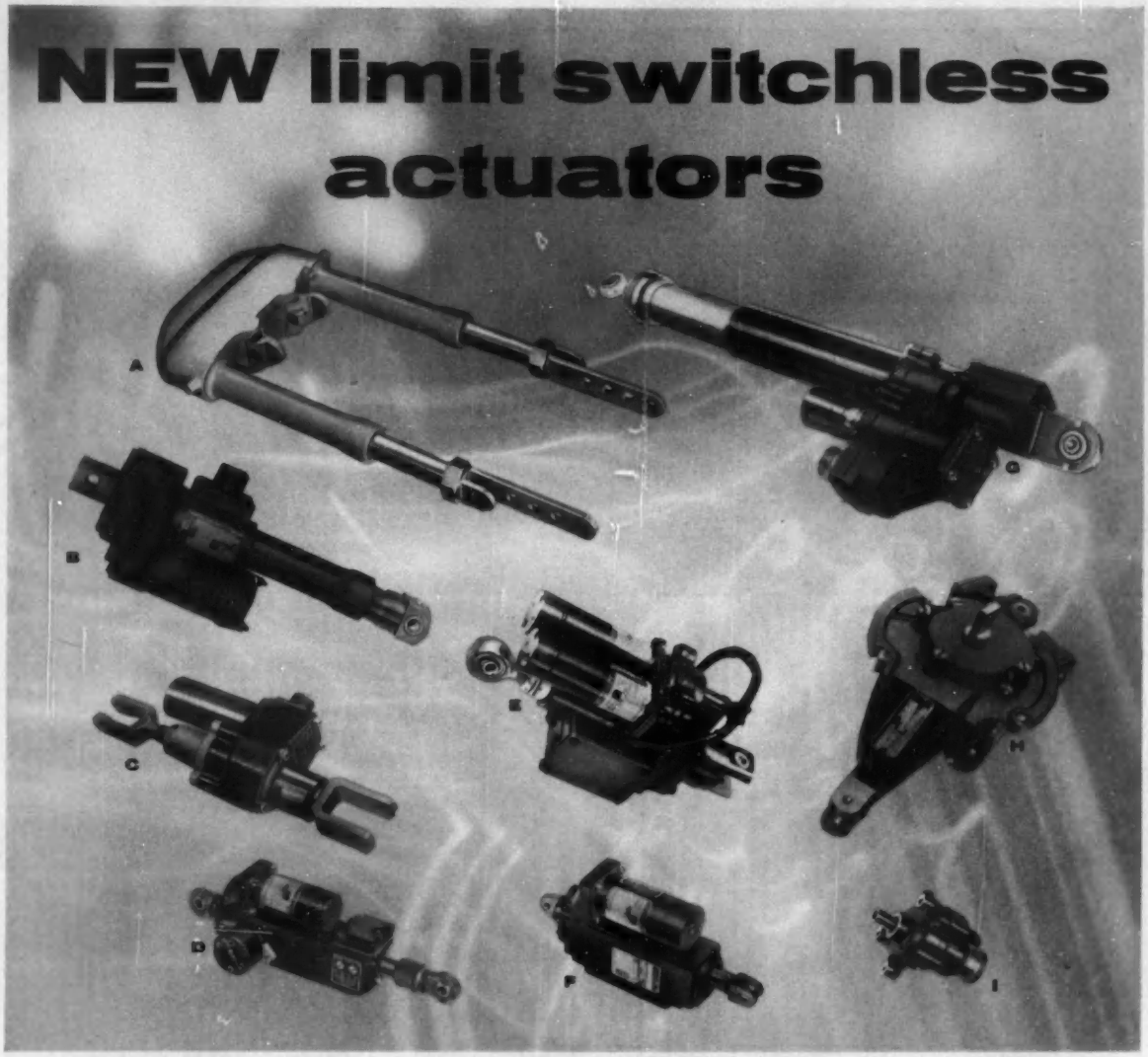
HERE'S HOW STROMBERG OUTPERFORMS THEM ALL

- Economical operation, more miles per gallon, happier customers
- Fewer moving parts, fewer mechanical failures, reduced service cost
- Substantially reduced incidence of icing and percolation
- Thin aluminum throttle body and flange for quicker heat transfer

Bendix-Elmira, N. Y.
ECLIPSE MACHINE DIVISION

Bendix
AVIATION CORPORATION

NEW limit switchless actuators



Reduce weight and cost 25% below conventional design

A reduction in actuator cost and weight up to 25 per cent, with similar maintenance savings, has been achieved through the advance design of AiResearch electromechanical Limit Switchless Actuators for aircraft and missiles.

Elimination of limit switches in power actuators is a result of AiResearch development of superior high temperature motors and resilient non-jamming positive stops.

Limit switches are eliminated by two methods: 1) use of continuous stall high temperature motors, 2) use of high temperature motors with thermal protectors which permit maximum *on* time in the duty cycle.

Additional advantages of AiResearch Limit Switchless Actuators: they are smaller, less complex and the possibility of limit switch failure is eliminated.

Development of Limit Switchless Actuators reflects AiResearch experience in producing more than a million rotary and linear units. Current production includes several hundred actuator types, many with high temperature applications.

Your inquiries are invited.

- **A** *Seat Actuator, CONVAIR B-58*
- **B** *Seat Actuator, LOCKHEED F-104*
- **C** *Rotor Blade Trim Actuator*
- **D** *Elevator Actuator, TEMCO XKDT-1 Target*
- **E** *2-Motor Trim Actuator, REPUBLIC F-105*
- **F** *General Purpose Linear Actuator*
- **G** *Dual Purpose Fuel Trim Actuator, AVRO CF-105*
- **H** *Rudder Trim, AVRO CF-105*
- **I** *Duct Shutter Actuator, LOCKHEED ELECTRA*

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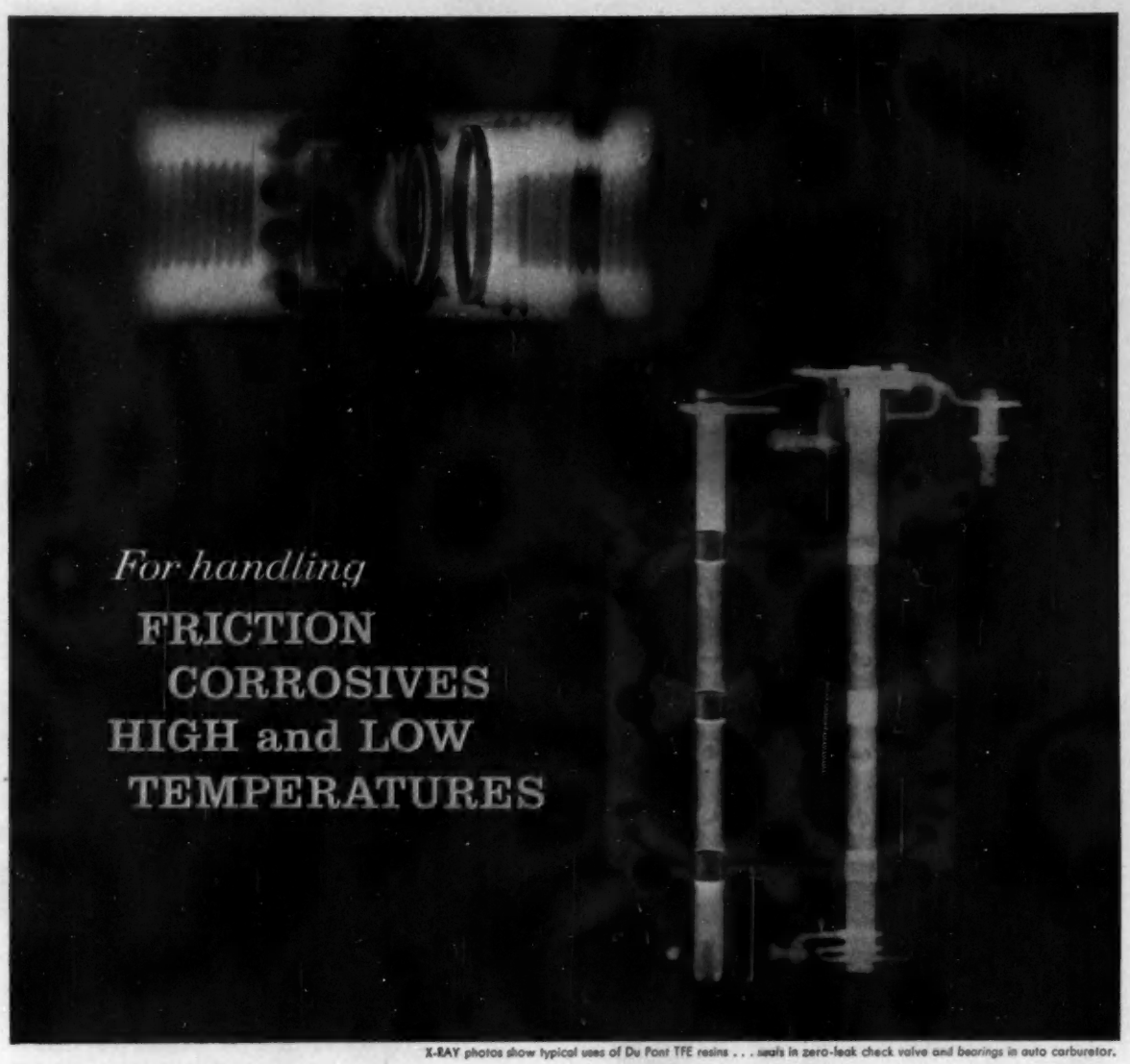
THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS



X-RAY photos show typical uses of Du Pont TFE resins . . . seals in zero-leak check valve and bearings in auto carburetor.

Here's why seals and bearings of TFE-fluorocarbon resins may be your solution

TFE-fluorocarbon resins have the lowest coefficient of static friction of any solid substance known. Under high loads, coefficients lower than 0.016 have been measured. The resins have practically universal chemical inertness and are rated for continuous use at temperatures from −450°F. up to 500°F.

TFE BEARINGS can operate dry in assemblies where lubrication is difficult or impossible, as the carburetor pictured above. These bearings eliminate "slip-stick" motion and remain unchanged in cold that turns alcohol to slush . . . cost 1/10th of the bearings they replaced. They perform unharmed in contact with gasoline, oil, grease, and automotive chemicals. TFE bearings can be tailored for high loads, high velocities or high wear resistance by the use of reinforced constructions.

TFE SEALS offer low friction, low torque, ease of operation. As in the valve shown above, they withstand exotic fuels, high pressures and temperatures from near zero Absolute to 500°F. TFE seals are available in all basic designs and configurations.

DISCOVER how you can improve automotive products and production by using seals and bearings of Du Pont TFE-fluorocarbon resins. For product and design information see your local supplier . . . look for him under "Plastics—Du Pont" in the Yellow Pages or write to: **E. I. du Pont de Nemours & Co. (Inc.), Room SA 2524, Nemours Building, Wilmington 98, Delaware.**

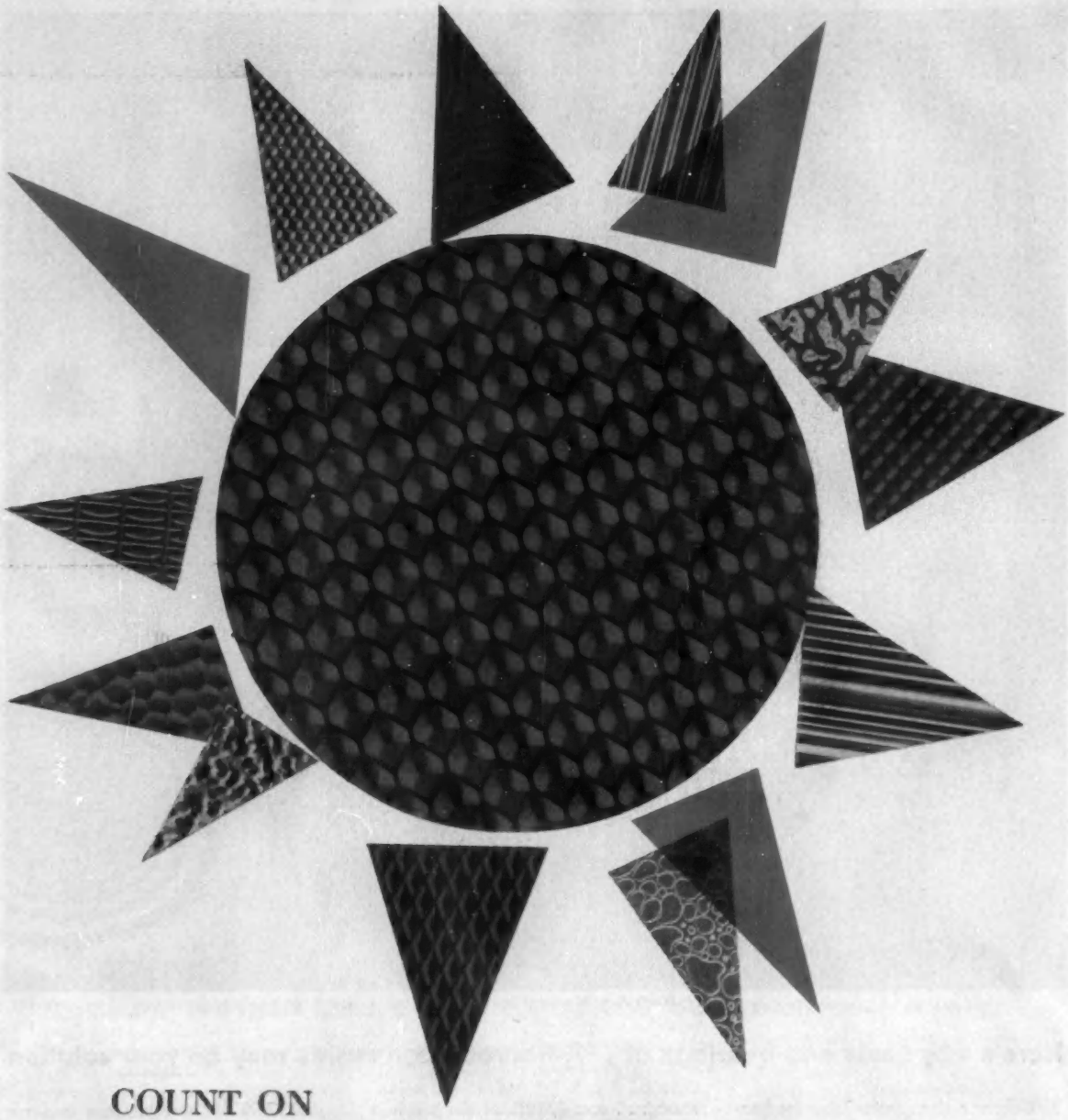
In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

DU PONT
REG. U.S. PAT. OFF.

TEFLON®
TFE-FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



COUNT ON FIRESTONE FASHIONIZED ALUMINUM FOR YOUR BIG ANSWERS IN BRIGHTWORK!

Count on Firestone's king-sized capacity for mass producing colorful low-cost parts and trim for automotive products and home appliances.

Whether you need big trim, small trim, or a lot of both—you need Firestone Fashionized Aluminum. You need the kind of equipment and experience that only Firestone and its streamlined new facilities can offer: the all-inclusive press sizes and capacities, the automatic transfer equipment and high-speed conveyors, the anodizing line that delivers 5,000 square feet of colored brightwork an hour —in part sizes up to seven feet long! In short, you should look into Fashionized Aluminum and Firestone's 50 years of experience in metal fabrication and finishing. Write, phone or wire today.

FIRESTONE FASHIONIZED ALUMINUM
FIRESTONE STEEL PRODUCTS COMPANY, AKRON 1, OHIO

THIS IS GLASS

a bulletin of practical new ideas *from Corning*

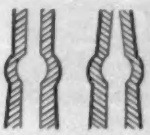
Hot tip!

This is a *glass* welding torch nozzle. You'll find them used on the inert gas welding rigs made by a number of up-to-date manufacturers.

Main reason for the *switch* to glass? You can keep close *watch* over the weld, *avoid* the kind of mistakes that can run into big money when you're working on expensive alloys.

Some of these welding nozzle tips are made out of VYCOR brand glass No. 7913, a 96% silica glass that's been *degassed*. Special firing to remove moisture reduces the tendency to deform at high operating temperatures.

All glass welding tips are fashioned from heavy-wall tubing that could be held as close as ±.001". Also, some pretty fancy machining and forming goes into them. One type calls for precision grinding of an outside taper, another for the same treatment on the inside—both for friction locking. And the tip we make for one firm has a bulb-like configuration to increase gas turbulence. All tips are fire-polished for added strength.



From all we've been able to discover, the men in the shop are quite enthusiastic about these rugged, heat-resistant glass tips that let them watch the welds go by. Likewise for the people who buy these tips from Corning and sell complete rigs to welders. They get what they need, when they need it, at a price that makes sense.

Special glasses, along with special techniques for either custom or mass production, await your appraisal. Which brings us to a standing offer: Bring us your knotty problem—product or process—and we'll see if we can't come up with a *glass* answer.

Or put some data at your fingertips by sending for Bulletin B-91, "VYCOR brand industrial glassware by Corning." In it you'll find all facts about infrared and ultraviolet transmission, heat and chemical resistance, and forms in which you can get these glasses.

How not to foul up the works

It's really very simple: If you're using spun insulation in electric motors, you have to keep the stuff from falling into the moving parts and fouling up the works.

Two things to keep in mind when selecting a material for this application: (1) It has to stand up to quite a bit of heat. (2) It *can't* be a conductor.

Some materials that are good insulators can't take the heat. Others function well at high temperatures but are not insulators.

Glass solves both problems. So, people who make electric motors build them with wedges made from PYREX brand glass No. 7740. (We supply the glass in rod form.)

This particular PYREX brand glass offers a number of useful characteristics. It is corrosion resistant and has a linear coefficient of expansion of 32.5 x 10^{-7} in/in between 0° and 300°C. Dielectric properties at 1 Mc and 20°C. are as follows:

Power factor	.46
Dielectric constant	4.6
Loss Factor	2.1

Wedges made from glass rod support spun insulation in electric motors. Glass is non-conducting and able to stand high temperature without deforming.

You can get PYREX brand glass No. 7740 in a variety of forms—pressed ware, blown ware, plate, tubing, rod and panels.

Mechanical, thermal, electrical, and chemical properties of this glass and 27 others are spelled out in Bulletin B-83. Check the coupon for a copy. Also ask for IZ-1, "Designing With Glass for Industrial, Commercial and Consumer Applications."

Blues in the white

Grand Coulee Dam is quite an impressive sight. It stands 550 feet high, and 4,173 feet wide. At night it's illuminated by 686 high wattage floodlights, covered with *colored front lenses*.

These lenses are red, green, blue, and yellow. And part of the lighting plan requires making *white* by *adding* red, green and blue.

That's where the trouble started. The equipment manufacturer required a very *precise* shade of blue. And despite years of experience in making colored glass, Corning had no blue on hand to do this job.

So our researchers came to the rescue. They developed a *special* glass and called it (for obvious reasons) "Front Glass Blue." Lenses made of this glass produced just the right shade. And along with the red, green and yellow lenses, they were *heat-resistant*, too.

Each lens used in this colorful spectacle measures 18 inches in diameter and weighs almost 7 pounds. All 686 were pressed from *standard* molds, delivered in record time.

O.K., you're not interested in color. Still there might be some glass or glass product that can be of help to you. Good introduction to the fascinating world of glass technology is the booklet, "This Is Glass." In its 64 pages you'll find facts and pictures that might give you some ideas. Remember: Corning can do almost anything with glass.

Corning means research in Glass

CORNING GLASS WORKS, 40-8 Crystal Street, Corning, New York

Please send me: B-91, "VYCOR brand industrial glassware by Corning" ☐ B-83, "Properties of Selected Commercial Glasses" ☐ IZ-1, "Designing With Glass for Industrial, Commercial and Consumer Applications" ☐ "This Is Glass" ☐

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Company.....

Street.....

City.....Zone.....State.....

- Experience
- Expert Workmanship
- Careful Inspection
- Pride of Production
- Honest Quality

NOTHING TAKES the place of these qualities.

Quality Performance

over 38 years of service to the automotive industries and their affiliates

from any point we are ready to produce for YOU.

We have tools and dies for many types of fuel tanks with irregular and unusual shapes and sizes.

O A L CO.

Write, wire or phone us for estimates and detailed information . . .

O. L. ANDERSON CO.
INCORPORATED
1347-87 EAST FORT STREET • WOodward 2-3460 • DETROIT 7, MICHIGAN
Manufacturers of
FUEL TANKS AND SHEET METAL ASSEMBLIES FOR THE AUTOMOTIVE INDUSTRY

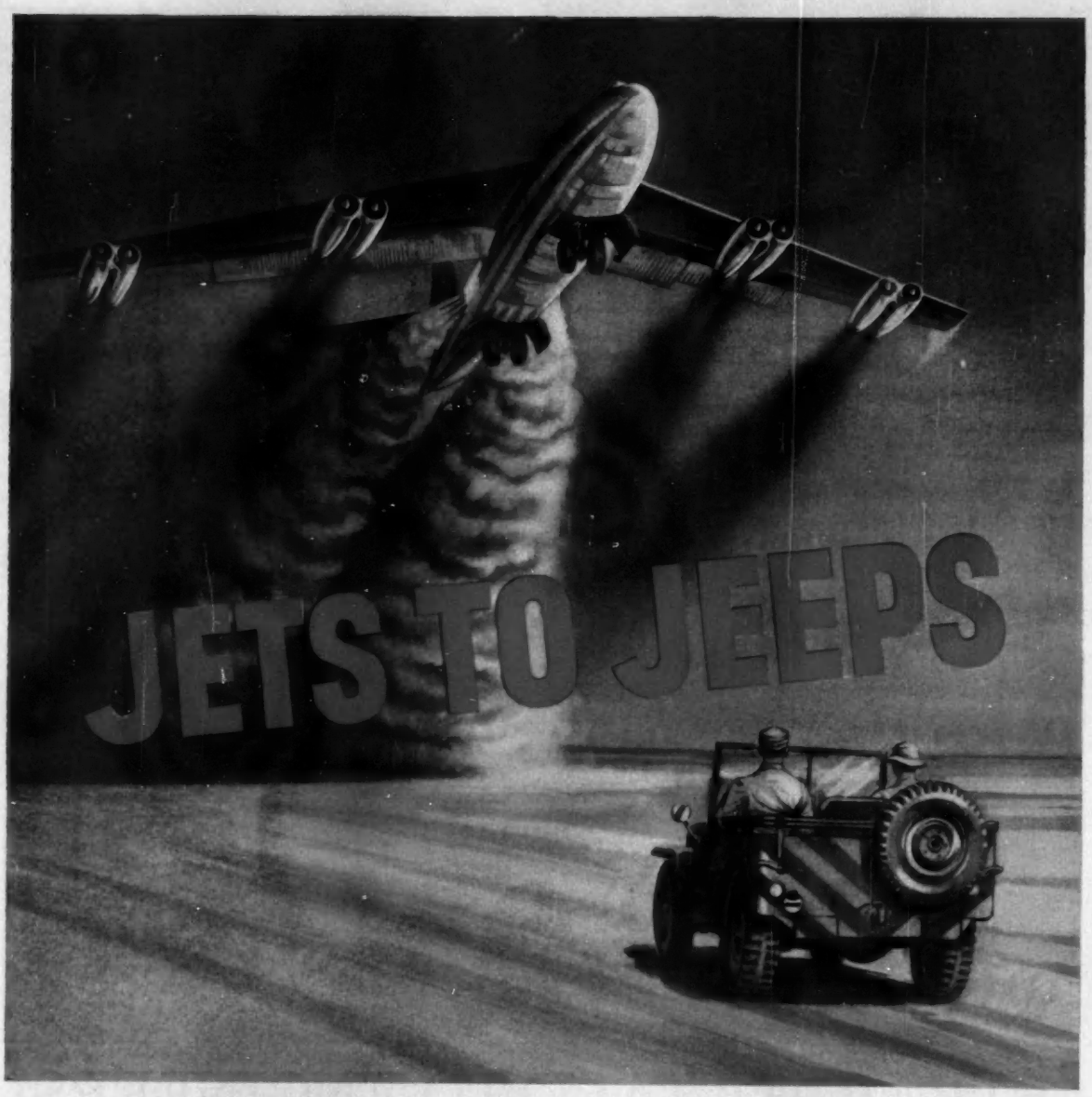
NEW OILMASTER RING SETS

WITH THE NEW HEPOCROM* chromium plated oil control ring

The NEW OILMASTER RING SET really does reduce oil consumption in partially worn engines, and will give new car performance. The basic ring, the NEW HEPOCROM Oil Control Ring, consists of two high tensile rails, chromium plated on the periphery, an inert cast iron spacer ring and a spring expander. NEW HEPOCROM Rings are efficient in use, easy to fit and there are no angles, tapers or special joints to worry you. New Oilmaster Sets open up new markets. There is the private motorist who knows he is using too much oil and is not getting peak performance, and also the motorist who cannot afford an expensive rebore job. In both cases a New Oilmaster Set is the answer.

HEPOLITE

Manufactured by HEPWORTH & GRANDAGE, BRADFORD, YORKS, ENGLAND



FRAM FILTERS FILL THE BILL!

From the screaming jet hurtling through the sky . . . gulping fuel by the gallon . . . to the rugged, little jeep rolling over the roughest, toughest terrain . . . every machine depends on engine protection to fulfill its mission. In every application where the pay-off is performance . . . FRAM Filters fill the bill!

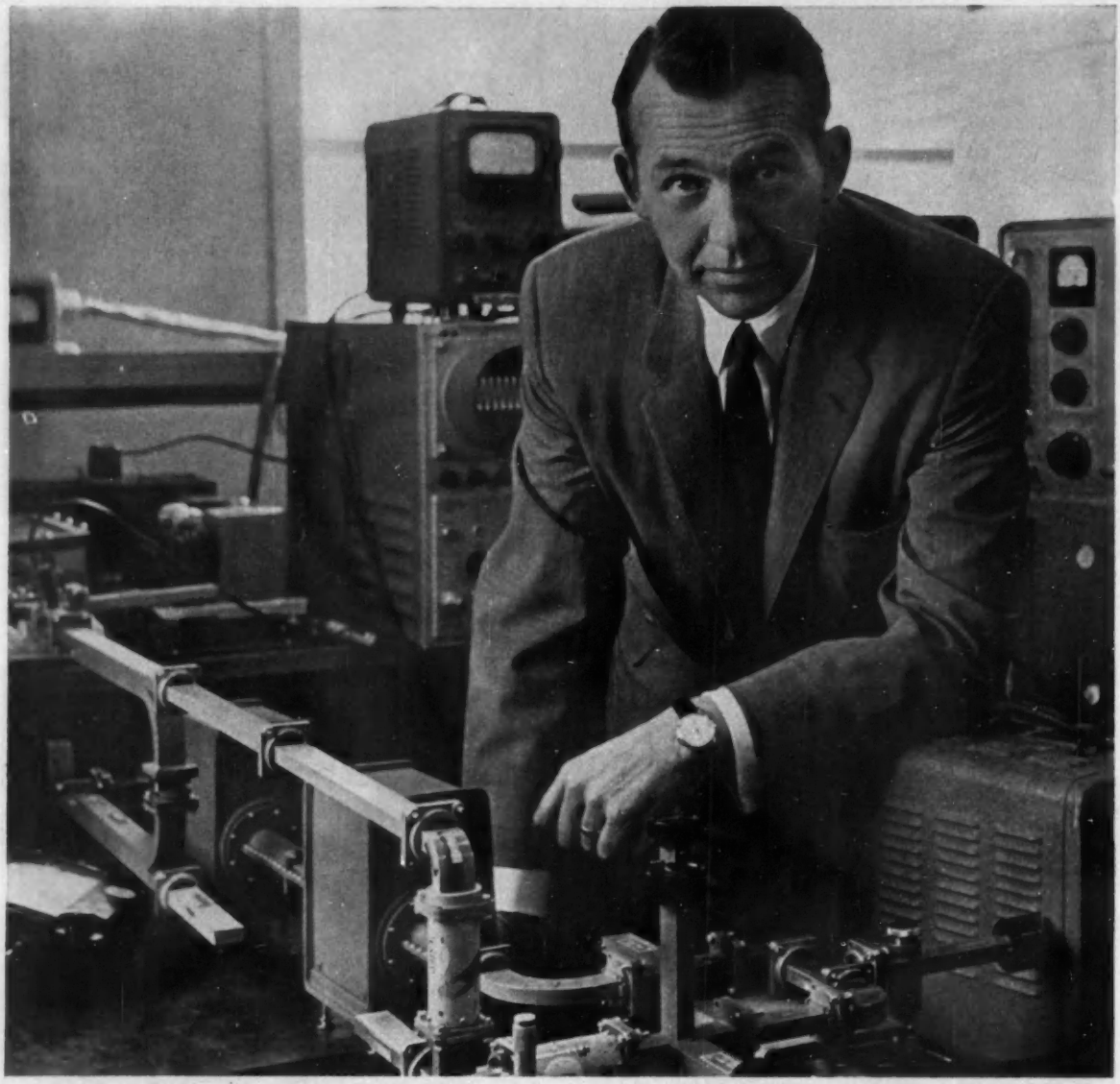
Whatever your filtration problem is, you will save time and money when you let experienced FRAM Filter engineers and technicians help you find the right solution.

At the FRAM Institute of Filter Research and Advanced Engineering . . . the world's finest filter laboratories . . . teams of FRAM Filter engineers and technicians are constantly pioneering in new, advanced filter design, methods and media. Over 400 manufacturers of precision products have already availed themselves of this service.

In the automotive field alone, more makes of automobiles have FRAM Filters installed as original equipment than any other filter in the world.

For full information on how to solve your filtration problems, write to:
FRAM CORPORATION, Providence 16, Rhode Island.

FRAM *oil-air-fuel-water* **FILTERS**



STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

In your field, as most of you well know, it's easy to be complicated . . . it's hard to be simple. At Douglas, I'm happy to say, we do things the "hard" way. This matter of simplicity is vitally important. We work intensive hours, days and months to achieve it.

Why this extra effort? Well, simple things work easier, last longer, are more easily maintained and are lots more reliable. We are rewarded for our greater engineering effort with a product that performs better for our various customers.

We know that good engineers, working in an atmosphere which stimulates them to do their best, have been largely responsible for our success. If you enjoy solving challenging problems in the simplest manner, we'd like to talk with you about joining us.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 620-O
Santa Monica, California

New Economy and Speed in Tooling Production for the Airframe Manufacturer with POLYTOOL

Photos courtesy of Arrowsmith Plastic Tooling, Inc., Los Angeles, Calif.

RCI EPOXY PLASTIC TOOLING COMPOUNDS

In the photos above you see a completed plastic stretch die and the laminating build-up stage in its fabrication.

This plastic stretch die has excellent dimensional stability. It is lightweight and was produced fast at low cost.

Reichhold, a basic manufacturer of resins, offers you a full line of epoxy plastic compounds for tool production.

POLYTOOL 2501 (white finish) and **2551** (metallic) are epoxy plastic tooling compounds for casting and laminating applications.

POLYTOOL 2502 (white finish) and **2552** (metallic) are epoxy plastic tooling compounds for gel coat application.

Reichhold supplies low irritation **POLYTOOL HARDENERS** for varying the gel time of these compounds. Reichhold also furnishes POLYTOOL compounds for a 3-component system with which you can vary working properties to meet specific requirements.

Why not investigate the **RCI POLYTOOL** line of plastic tooling materials? It includes not only epoxy, but also polyester, phenolic and polyurethane resin systems. RCI offers you outstanding quality control of these materials.

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol
Hydrochloric Acid • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sebacic Acid • Ortho-Phenylphenol • Sodium Sulfite
Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenol
Sulfuric Acid • Methanol

REICHHOLD CHEMICALS, INC.,
RCI BUILDING, WHITE PLAINS, N.Y.

Creative Chemistry... Your Partner in Progress

NEW

LOW COST "Utility"

HUCKBOLT FASTENER

(AVAILABLE IN STEEL OR ALUMINUM)

OFFERS:

LOW COST—An economy model of the well known Huckbolt Fastener offering the desirable features of that fastener plus some special features of its own.

BROAD GRIP ADAPTABILITY—Six sturdy locking grooves on the fastener pin allow an unusual grip extension for each grip-size of pin.

THREE HEAD STYLES—The "Utility" fastener is offered in standard brazier, round and 90° countersunk heads to meet your requirements.

TWO COLLAR TYPES—The "Utility" fastener may be used with standard 2LC collar or with the 3LC which has a broad, sturdy, pre-engineered washer as an integral part.

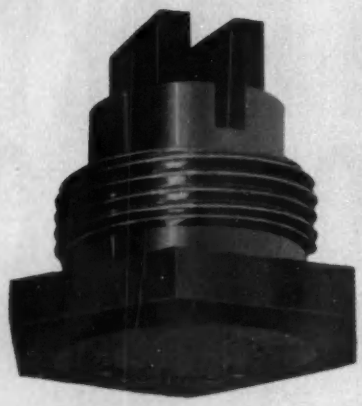
FULL STRENGTH—The "Utility" fastener offers full rated tensile strength of the standard CL fastener, diameter for diameter.

CUTS STOCK REQUIREMENTS. Six annular locking grooves provide greater grip flexibility thus affording full coverage of your requirements with fewer grip sizes.

HUCK *MANUFACTURING COMPANY*

2480 BELLEVUE AVENUE • DETROIT 7, MICHIGAN • Phone WA. 1-6207

PROLONG ENGINE LIFE WITH



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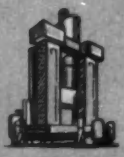


HYDRAULIC SYSTEMS

PUMPS

AIRCRAFT ENGINES

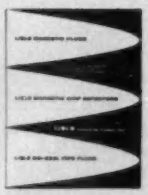
ENGINES AND TRANSMISSIONS

LISLE *Magnetic* **PLUGS**

Engines, pumps, gear cases, transmissions and hydraulic systems all benefit when Lisle Magnetic Plugs are used. They remove razor-sharp abrasive bits of metal — preventing them from scoring and pitting raceways, bearings, cylinder walls and other critical parts and surfaces.

A powerful, permanent magnet pulls out and holds the harmful ferrous particles present in the circulating lubricant.

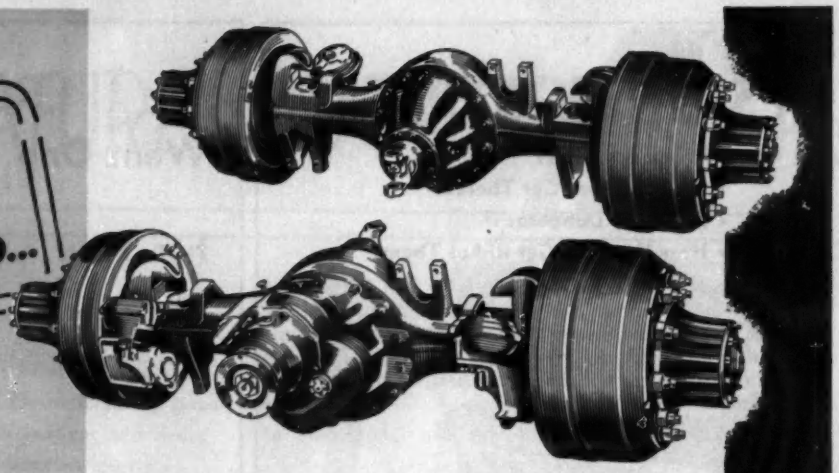
Hundreds of different Lisle plugs are kept in stock for all types of applications.



WRITE FOR NEW FREE CATALOG
Sample plugs for testing will also be sent free upon request.

LISLE
CORPORATION
Clarinda, Iowa

PROVED AND PREFERRED...



For three years..

Timken-Detroit® Lightweight Driving Tandems—First Choice With Big Over-the-Highway Operators!

These superior features make the difference:

Lighter than any comparable tandem on the market . . . but a real heavyweight when it comes to service. Besides increased payloads you get long, trouble-free service and lower operating costs. Time-proved, Timken-Detroit Lightweight tandem features include:

Driver Controlled Inter-Axle Differential. Torque is divided equally between axles, yet wheels of one axle can turn faster or slower than wheels of other axle. This means both axles are always doing equal amounts of work. Driving parts and tires last longer.

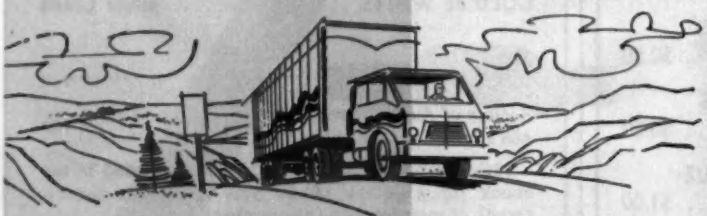
"In-Line" Propeller Shaft Drive. With straight-through drive, bearing and gear life is greatly increased because universal joint working angles are materially reduced.

Torsion Flow Axle Shafts. More splines, plus greater root and body diameter, add extra strength.

Hot Forged Rectangular-Shaped Axle Housings. Rectangular shape, combined with full strength corner sections, provides the greatest strength with minimum weight and size. Welded on bowl cover prevents leakage.

Hypoid Gears. Larger pinions and greater tooth contact give 30% more torque capacity, top efficiency and long life . . . plus lower maintenance costs.

Unmatched Parts Interchangeability. Most of the wearing parts—gears, bearings, shafts, differentials, brakes—are interchangeable with parts from Timken-Detroit standard single axles. Parts are readily available and less expensive.



WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSES AND TRAILERS

TIMKEN Detroit AXLES
ROCKWELL-STANDARD CORPORATION
TRANSMISSION AND AXLE DIVISION
DETROIT 32, MICHIGAN
Accepted Standard

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Products of ROCKWELL-STANDARD Corporation

Seminar on

RESIDUAL STRESSES

- **What Are They?**
- **How Do They Get There?**
- **Are They Dangerous?**
- **How Can You Get Rid of Them?**

Prof. R. Weck of Cambridge University and Director of the British Welding Research Association, will be brought to America this October to deliver seven important lectures on residual stresses. Coupled with these outstanding lectures will be seven discussion periods by 14 American experts.

This Seminar will be held during the latter part of Metal Show Week

October 30, 31 and November 1, 1958

Place: Wade Park Manor, Cleveland

Registration Fee: Including lunches and dinners for the three days, $150.00. (Early registration with $25 deposit suggested)

Mail your reservation now—or write for folder giving complete details of this important ASM Metallurgical Seminar to

American Society for Metals

Metallurgical Seminar Division

7301 Euclid Avenue Cleveland 3, Ohio

NOW AVAILABLE

AERONAUTICAL INFORMATION REPORTS ON AIRCRAFT GREASES (DATED MARCH 1, 1955)

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Want One For Your Lapel?

An SAE Emblem

- **Distinguishes you as an SAE member**
- **Is an attractive gold-filled clutch-back pin**
- **Costs only $1.50 plus 15¢ Federal tax for delivery in the United States and 5¢ sales tax for delivery in New York City**

ACTUAL SIZE

GOLD on BLUE ..... Member Grade
GOLD on RED ..... Associate Grade
GOLD on WHITE ..... Junior Grade

Society of Automotive Engineers
485 Lexington Ave., New York 17, N. Y.

Please send me an SAE emblem. Enclosed is my check for $..... ($1.50 plus applicable taxes). Grade of membership (please check)

☐ Member ☐ Associate ☐ Junior

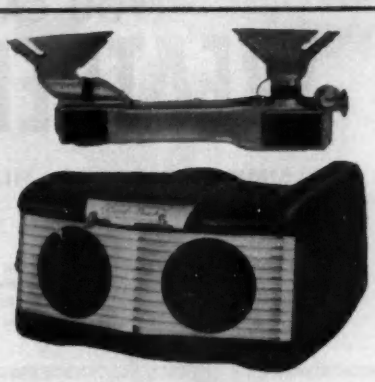
Name .....
(PLEASE PRINT)

Address .....

TEMPERATURES MADE TO ORDER!

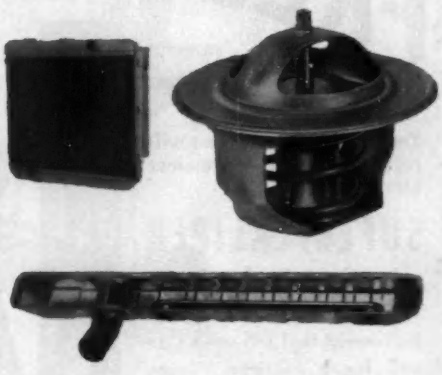
INSIDE THE CAR

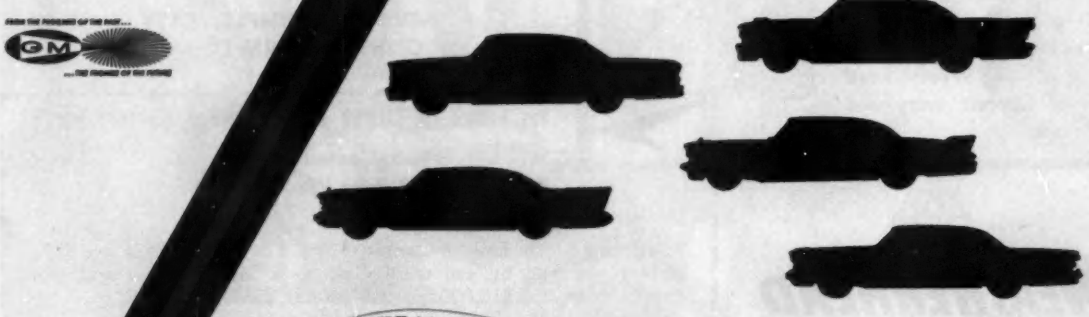
Comfort's always in season in General Motors cars. With winter's icy blasts outside, Harrison Heaters and Defrosters keep passengers snug and warm—windows clear and clean. And during the warm weather months, Harrison Air Conditioning beats blazing heat, sweltering humidity, dirt and road noise for the coolest, most comfortable ride on the road.



IN THE COOLING SYSTEM

Harrison Radiators, Thermostats and Oil Coolers insure top engine and transmission performance for the world's finest cars and trucks. Harrison heat control products, backed by more than 47 years' experience, are engineered to assure dependable, economical service. If you have a heating or cooling problem, look to Harrison for the answer.





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HARRISON RADIATOR DIVISION • GENERAL MOTORS CORPORATION • LOCKPORT, NEW YORK

Easy Money! Everybody Wins!

YOU CAN'T LOSE IN THIS BIG . . .

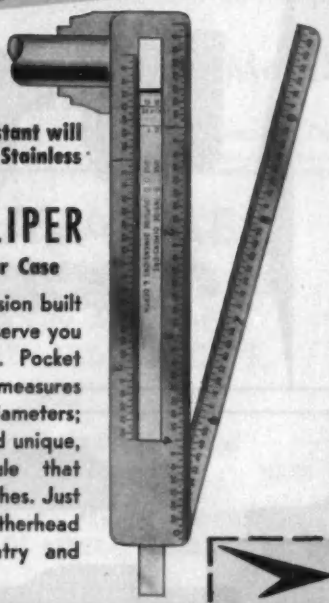
WEATHERHEAD WIN WITH ERMETO® CONTEST

SIMPLE, EASY TO FILL OUT, CONTEST FORM MAILED ON REQUEST

. . . SEE COUPON BELOW

We want the simple facts on a wide range of Weatherhead high pressure Ermeto Fitting Applications. Send for the questionnaire now. Take a few minutes to fill in and mail. You will receive the Super-Caliper as our token of appreciation—and your entry will also be entered in the $15,000.00 cash awards contest.

FREE!



You and Every contestant will receive this Quality Stainless Steel

SUPER CALIPER

In Genuine Leather Case

A high-quality precision built instrument that will serve you well for a lifetime. Pocket size—5½" long; measures inside and outside diameters; has depth gauge and unique, built-in folding rule that opens out to ten inches. Just send in your Weatherhead Ermeto Contest entry and it's yours.

$15,000.00

IN CASH AWARDS

185 WINNERS

1st Prize		$ 1,500.00
2nd Prize		1,000.00
Next 8 Winners	$750.00 each.	6,000.00
Next 35 Winners	100.00 each	3,500.00
Next 40 Winners	50.00 each	2,000.00
Next 100 Winners	10.00 each	1,000.00
Total Winners 185	Total Cash Awards	$15,000.00

CONTEST CLOSES SEPTEMBER 30, 1958

SEND FOR SIMPLE, EASY CONTEST FORM TODAY

Yes I Want the CALIPER and a Chance at the EASY MONEY

Win with Ermeto Contest
P. O. Box 2457, Fort Wayne, Indiana

Gentlemen:

Please rush simple Ermeto Contest form. I understand that my filled in form received by you entitles me to a Super Caliper and also enters me in the $15,000.00 cash awards contest.

NAME _____

STREET _____

CITY _____

STATE _____

WEATHERHEAD

FIRST IN HYDRAULIC COMPONENTS

THE WEATHERHEAD CO.
Fort Wayne Division
Fort Wayne, Indiana

In Canada:
The Weatherhead Co., Ltd., St. Thomas, Ontario

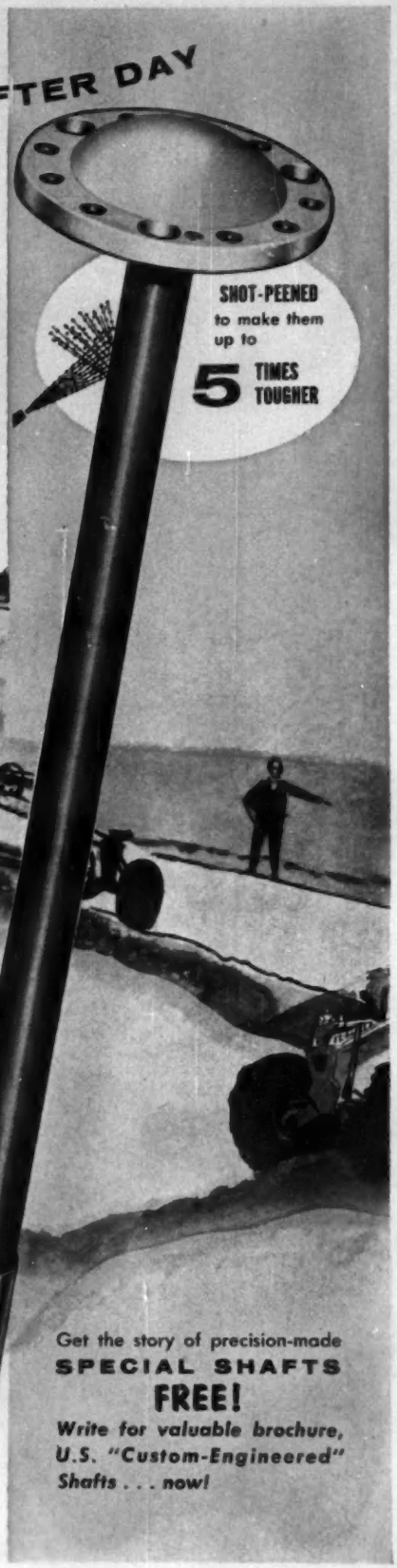
MILE AFTER GRUELING MILE
DAY AFTER DAY AFTER DAY

UNUSUAL performance is USUAL with

US® AXLE SHAFTS

And good reason why! Developed during our 38 years of concentration on shaft engineering, the industry's most modern heat-treating methods at U.S. AXLE strengthen fine alloy steel. Shot-peening makes shafts up to *5 times tougher*, by actual torsion tests.

There's a U.S. AXLE SHAFT for every wheel that turns . . . on vehicle or production equipment. Depend on U.S. skilled engineers who *know how* to design and build "the" axle for UNUSUAL performance and savings . . . to do *your* job better.



"THE WORLD TURNS ON U. S. AXLES"

Get the story of precision-made
SPECIAL SHAFTS
FREE!
Write for valuable brochure, U.S. "Custom-Engineered" Shafts . . . now!

THE US AXLE COMPANY, INC.
Since 1920 • Pottstown, Pennsylvania

where big jobs beat schedules!

Firestone Perma-Tite Rims—
100% fusion-welded for maximum strength!

Exclusive fusion-welding helps make Firestone Perma-Tite rims the strongest you've ever used. Firestone Steel Products Company's balanced weld design gives equal penetration, throughout the section, for maximum dependability. The Perma-Tite rim provides a complete air seal with the tire mounted on it. Its unique design results in more accurate rim dimensions, makes possible more efficient wheel assemblies; insures a permanent air seal and reduces operator downtime.

Stress tests result in rims specially reinforced at high strain points. Available for tube or tubeless-type off-the-highway tires. Specify Firestone Perma-Tite rims as original equipment. Buy them for replacements.

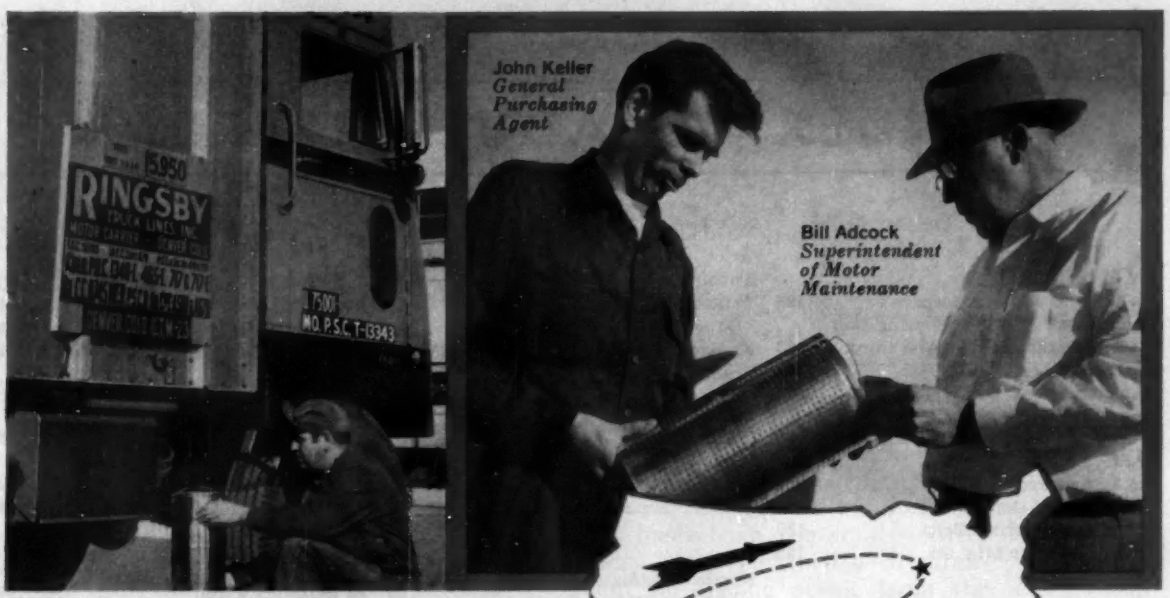
COMPLETE AIR SEAL . . . the greater the pressure, the tighter the seal.

SPECIAL PROTECTION against rust and corrosion for longer rim life, better tire performance.

INTERCHANGEABLE in complete units or by components with all earthmover rims and parts.

FIRESTONE STEEL PRODUCTS CO.

AKRON 1, OHIO



Bill Adcock, Supt. of Motor Maintenance RINGSBY TRUCK LINES, Inc., says:

"Our 'RINGSBY ROCKET' Averages 10,000 miles before we change oil and DIESELPAK"*

Makes 2 non-stop runs Los Angeles to Chicago—with superior oil filtration—at a COST LESS THAN 4¢ PER 100 MILES

Only LUBER-FINER DIESELPAK, with its *exclusive* specially processed media, removes oil contaminants *effectively*—FAR LONGER THAN ANY SUBSTITUTE PACK.

DIESELPAK—designed expressly for use with H.D. detergent compounded oil—removes not only injurious suspended solids, but also colloidal impurities (often more destructive) *without affecting the additives.*

Thus LUBER-FINER DIESELPAK

1. COSTS LESS than ineffective substitutes because it gives MORE MILES of *effective filtration.*
2. Also ADDS THOUSANDS OF MILES to ENGINE AND OIL LIFE because its exclusive engineered protection CLEANS OIL FASTER AND KEEPS IT CLEAN LONGER.

STANDARD AND OPTIONAL EQUIPMENT—On leading Diesel Trucks, Tractors and Stationary Engines.

*A typical statement of many users, engineers, and original equipment manufacturers on file.

VISUAL PROOF why DIESELPAK is The Standard of the Industry

Positive end seals prevent the oil from by-passing. The oil is filtered through the patented media of the DIESELPAK which removes colloidal particles and other contaminants without adversely affecting the additives.

The oil then passes through several layers of protective fibrous material which is scientifically engineered to positively prevent media from migrating into the engine.

World renowned engineered protection is enjoyed only by the users of the genuine LUBER-FINER "DIESELPAK."

Luber-finer

WRITE FOR INFORMATION--how to get MORE MILES of effective lubrication at LESS COST. Dept. F-1.

LUBER-FINER, INC.
2514 South Grand Avenue, Los Angeles 7, California

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XXVIII

This is the twenty-eighth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Cold-Finishing of Alloy Steel Bars: Turning and Polishing

Continuing our discussion of the cold-finishing of alloy steel bars, we take up the subject of turning and polishing. A later discussion will cover grinding and polishing. Both require removal of surface metal. In both the turning and grinding operations, adequate allowances provide for the removal of decarburization and surface defects which sometimes occur in alloy bars.

As previously stated, the outstanding advantage of cold-drawn bars over hot-rolled bars is the *bright, smooth finish*. However, the quality of the cold-drawn finish varies with the size and amount of draft (reduction of cross-sectional area) applied in cold-drawing. For example, by using a 1/16-in. draft, a 3/4-in. round would have a better cold-drawn finish than a 3-in. round.

When a superior mirror-like finish with additional accuracy is required on surfaces that are not machined (such as on shafting or machine parts), two processes other than cold-drawing are suggested: turning and polishing, and grinding and polishing. The first of these will be discussed here.

Turning and Polishing. This method of cold-finishing is generally associated with centerless bar-turners, accommodating rounds from 1 1/4-in. to 6-in. diam, inclusive. The process is the reverse of conventional lathe-turning, which is normally used for larger sizes. The centerless turning equipment uses two cutter heads which contain from one to four cutting tools. The system provides for both rough and finish cuts. The bar, which is stationary, is fed horizontally into the rotary cutter heads by means of a mechanical or hydraulic feeding mechanism. Most bar-turners are equipped with a series of polishing rolls that also rotate around the bar as it feeds from the rotary cutter heads. This, combined with subsequent burnishing action from the straightening rolls, imparts a high degree of polished finish to the product. A polished surface on a turned bar can also be produced by a number of passes through the straightening rolls.

This process is applicable to normalized, annealed, or heat-treated carbon and alloy bars. It does not materially affect the mechanical properties. For this reason, the end product can be machined unsymmetrically, with little or no tendency to warp.

Bethlehem metallurgists will gladly work out any problem in the cold-finishing of alloy steel bars. Always feel free to ask for their services.

When you are in need of steels remember, too, that Bethlehem manufactures the entire range of AISI standard alloy grades, as well as special analysis steels and all carbon grades.

If you would like reprints of this series of advertisements, please write to us, addressing your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa. The subjects in the series are now available in a handy 40-page booklet, and we shall be glad to send you a free copy.

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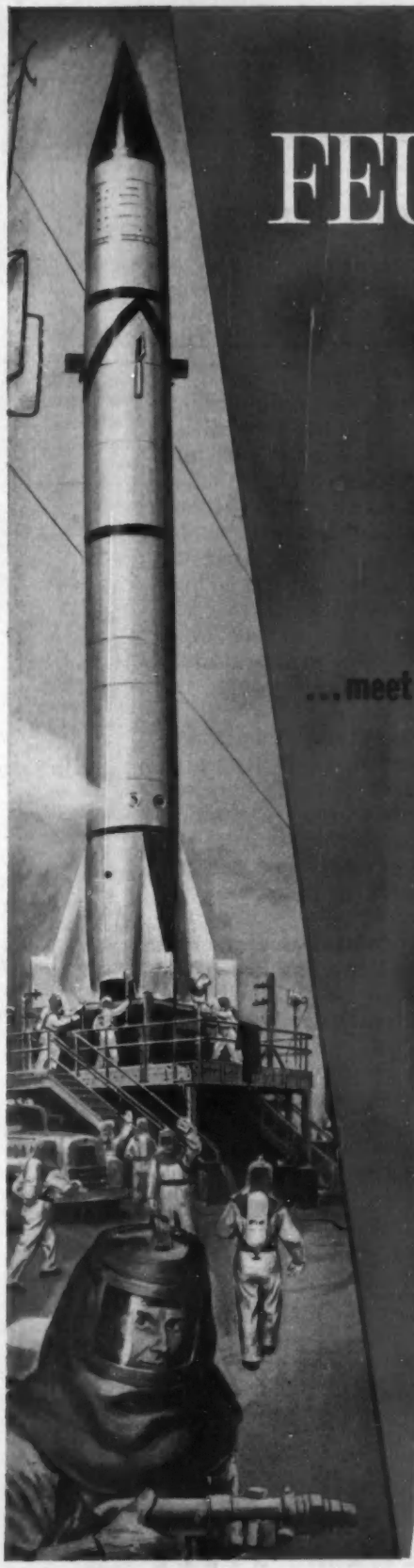

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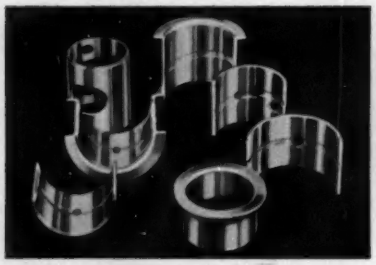
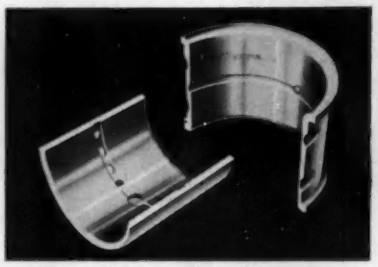


BABBITT AND STEEL



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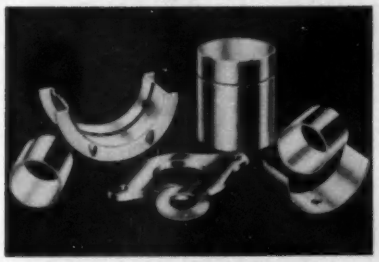
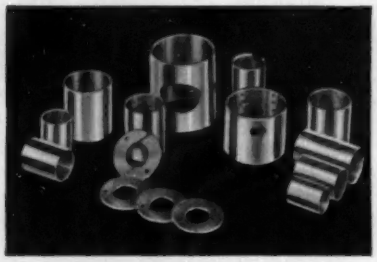
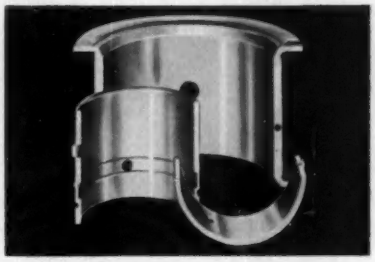


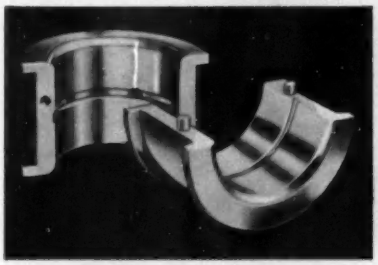
BRONZE OR COPPER-LEAD ON STEEL



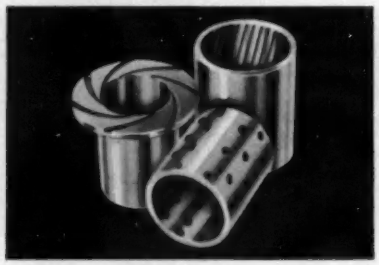
ROLLED BRONZE



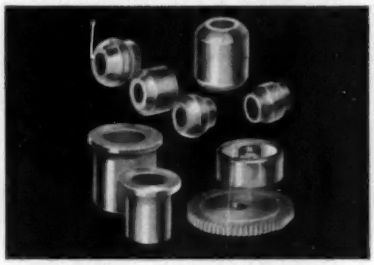
ALUMINUM ON STEEL



CAST ALUMINUM ALLOY



GRAPHITED BRONZE



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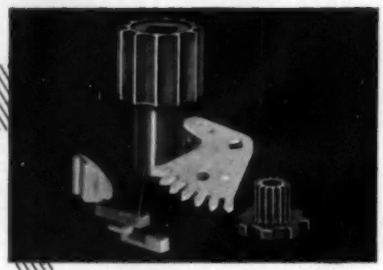

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